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HUNTING IMPLEMENTS AND METHODS OF THE PRESENT-DAY ESKIMOS OF NORTH-WEST HUDSON BAY, MELVILLE PENINSULA, AND SOUTH-WEST BAFFIN ISLAND

T. H. MANNING

IN this paper I attempt to describe the present-day hunting activities of the Eskimos of Southampton Island, Wager Inlet, Repulse Bay, Igloolik, Foxe Peninsula, and the intervening territories. Although during much of the seven years I was in the region I travelled without Eskimos or lived in an area they seldom visited, circumstances, combined with personal inclination, led to my using many of the Eskimo customs as a necessity for existence. I therefore took every opportunity of learning their methods of hunting.

Modern Eskimo hunting implements

Rifle.—The rifle is the most essential of the Eskimo hunting implements. This varies in calibre from a ·303 British to a ·22. The commonest calibre is a 30·30 or a ·303 Savage, though in the Chesterfield, Southampton Island, and Igloolik districts, the 25·35 is becoming increasingly popular because of its lightness and the comparative cheapness of the cartridges. The 25·35 is ideal for seals and bears, and quite adequate for walrus so long as the position of the brain is carefully noted and hard point bullets used. For caribou, a heavier calibre is preferable since it is not always possible to be sure of hitting a vital spot, but unfortunately Eskimos worry little over the escape of a wounded animal. The ·303 British is now little used. Several families have a ·22 which may be used as a secondary rifle by the head of the family, or given to the son when he is about ten years old as his first rifle. Eskimos like the smallest possible sights, and will always file them down to suit their own requirements. A few Eskimos have shotguns, but they are not used to any great extent owing to the cost of the ammunition. A ·22 rifle is much cheaper and almost as efficient for shooting birds and rabbits. Shotgun, and occasionally rifle, cartridge cases are saved and re-loaded.

In summer, an Eskimo's rifle is in almost continuous use, and is of necessity

often exposed to rain and salt water, since when boating it must be kept ready at hand in case a seal suddenly bobs up within range. Eskimos do not see any sense in using expensive gun oil on the outside of a rifle, and for this reason it soon becomes rusty and ancient-looking. It will usually be found however, even in old rifles, that the mechanism is in good condition, and that the barrel has been kept free of rust by constant use. During the winter, rifles must always be kept outside the snowhouse to avoid the condensation which would form on the cold steel if it were taken into the warmth, and with temperatures of −10° F. and below, all oil must be cleaned from the trigger mechanism. When travelling by sledge, the Eskimo, after lashing his load, tucks his rifle into the side so that it will be ready for instant use. Sometimes rifles are carried in a duck bag; sometimes they are left uncovered and a tuft of dog or bear hair is stuffed into the muzzle to keep out the snow. Although Eskimos are often criticized for the lack of care given to their rifles, I think few white men, living under the same conditions and using a rifle as constantly as Eskimos do, would make it last better.

A rifle will last a good hunter three or four years providing it is not lost or broken. After that time it is passed on to a poorer hunter, and will finally be used for spare parts. Spare stocks and sights are in greatest demand, as these are frequently broken or torn off and lost.

Winter harpoon.—The Eskimos have harpoons of two types: that for winter use is designed primarily for harpooning the seal through its small breathing-hole in the ice, and is therefore smaller and lighter than the harpoon used in summer hunting of bearded seals, walrus, white whales, and narwhals. It consists of a short wooden handle rigidly attached to an iron foreshaft about three-eighths of an inch in diameter and rather over 2 feet long. At the opposite end of the shaft there is often an ice chisel made from three-quarters to one-inch rod iron. The harpoon head is made of metal, usually brass, with a sharpened piece of saw blade or some such good steel riveted in to form the cutting edge. The point of the foreshaft fits into a hole in the harpoon head which is held in place by the taut harpoon line. If the harpoon is being thrown at a seal carcass floating near the floe edge the line is passed through a loop on the shaft, so that the shaft can be drawn back after the throw; but when striking at a seal through the ice this loop is not used, since the attached shaft would only be in the way.

Summer harpoon.—The wooden shaft of the summer harpoon is both longer and heavier. The foreshaft is generally made from a single walrus tusk selected for its straightness, but if a suitable one is not available pieces from two are scarfed together. The foreshaft is not rigidly attached, but its rounded base is lashed with skin line into an ivory socket on the wooden shaft. The summer harpoon head is considerably larger than the winter, and the brass of the latter is replaced by ivory. Both the winter and summer heads are fixed to the foreshaft in the same manner.

Avatuk.—When white whales or walrus are being harpooned, the end of the harpoon line is commonly attached to a float or *avatuk* made from the complete skin of a ringed seal. For this purpose the skin is removed by two cuts only: one just in front of the hind-flippers, and the other just behind the eyes. After turning the skin inside out, the fat is cut away, and the meat and

bones removed from the fore-flippers, which in skinning had been severed at the wrist. It is then turned hair side out, and the skin about the back opening tightly bound with twine around a stick placed crosswise so as to act as an attachment for the line. The front end is bound round a piece of ivory with a hole left in the centre for inflating. Once inflated, a soft wooden peg is used to block the hole. The hair is shaved off with a steel *ulu*, or knife, while the skin is inflated, after which it is again turned, blown up, and left to dry in the sun. If a small hole is made in the skin at any time, it is closed by means of a double button resembling a large collar stud around the middle of which the skin is tightly tied. A flipper is the most usual place for a leak to develop, but it can easily be tied off at the wrist. When inflated, an *avatuk* will stand great pressure, even on sharp pebbles, and is often used to support a heavy whale-boat while it is being hauled up.

Harpoon line.—Harpoon line, like all other skin line, is prepared from the hide of the bearded seal (or occasionally the harp seal). When the skin is needed for line, it is removed in rings about 8 inches wide encircling the body. The line is cut in the required width helically from the ring, each ring producing 30–40 feet of line according to the width desired and the size of the seal. Once or twice during drying the line is stretched taut, preferably with block and tackle. When thus stretched it can be trimmed to an even width: in summer with a knife, but in winter, when the line is frozen, a plane produces better results.

Hunting screens.—A screen is sometimes used for hunting seals on the ice. This consists of a piece of white cotton material about 4 feet high by 2½–3 feet broad; there is a peep-hole to look through, and pockets at the corners to fit over a frame. The frame is made from two sticks of wood which are crossed in the centre and fixed with a single nail so that they can be folded together when not in use. Since the screen must be absolutely white and clean, it is carried in its own special bag.

Fish nets and leister.—Gill nets of variable dimensions are used for catching fish. These nets average some 40 feet long, and 5 feet wide. They are sometimes bought ready made and sometimes netted by the Eskimos themselves from twine purchased at the trading posts. The large-meshed nets of heavy twine used for catching whales and seals are made in the same way.

A leister, or pronged fishing-spear, is also used. The handle, often 12–16 feet long, is of wood; the best side pieces are made of musk-ox horn which is shaped after being immersed in hot water. Since musk-oxen are confined to the central mainland and northern islands, caribou antler is the common substitute.

Traps.—Steel traps are almost as important a part of Eskimo equipment as the rifle and, like it, must be purchased from the trader. For foxes, a No. 4 trap with a single spring is most favoured; smaller traps, originally intended for weasels, are occasionally used. Weasels are often caught accidentally in fox traps. Wolves may also be caught in these traps, but a large double-springed trap is preferred. Not many Eskimos have any of them. Traps of stone or ice are now used only in exceptional circumstances. On Southampton Island traps are occasionally set for polar bears; these have very large double springs and toothed jaws.

Boats.—Boats are both a means of transporting families when moving camp during the summer, and a necessity for hunting. The Eskimos of the west coast of Hudson Bay and Melville Peninsula no longer use kayaks; indeed, as a rule they have lost the art of making them, and are dependent on imported boats or canoes. The commonest boat is still the open whaler of between 26 and 28 feet with sail and centreboard, but the tendency now is to get larger boats quarter decked and equipped with engines; a few natives have fully decked Peterheads. Canvas freight canoes are more used at Repulse Bay than elsewhere, perhaps because walrus are rarely hunted. A favourite length for canoes is 18–20 feet. Besides the larger boats and canoes used for summer hunting and transport, some kind of small craft easily transportable on a sledge is needed for retrieving seals shot at the floe edge in winter. Occasionally a freight canoe may be used, but apart from the difficulty of sledging this through rough ice it is very hard to paddle through sludge ice. Sometimes a small dinghy is bought from the trader, but more often a rectangular, box-like boat is fashioned from pieces of rough wood nailed together. When this is used in the comparatively mild weather of spring and fall, it is waterproofed with a covering of sealskin, but in winter ice caulks the seams immediately the boat is placed in the water.

The Eskimos in south Baffin Island and in Hudson Strait still use kayaks, although they also hunt from wooden boats as do the Southampton Island, Chesterfield, and Igloolik Eskimos. The advantages of the kayak lie in the ease with which it can be started or turned to reach a sinking seal, and in its quietness and inconspicuousness which render close approach to an animal possible; but the labour involved in the construction (it will last only two years) and the danger of hunting walrus in so slender a craft, are decided drawbacks. Since I have no personal experience of hunting from a kayak, I shall not attempt a description.

Hunting methods

Winter seal hunting.—During the winter, some ringed seals keep to the open water; others, particularly the females and older males, live under the ice, breathing at cone-shaped holes about 1 or 2 inches across at the top and sufficiently wide below to admit the seal's head and body if the ice is thick. Bearded seals are also found at the floe edge and under the ice, but only where it is thin. Ranger seals are sometimes shot at the floe edge, but I have not heard of any being killed through the ice. Harp seals leave Hudson Bay and Strait for the winter.

Seals are killed in winter either by shooting them in the water from the floe edge or by harpooning them at their breathing holes in the ice. When possible, the first method is adopted because it produces better results and because it is much pleasanter to walk about at the floe edge waiting for a seal than it is to remain motionless over a breathing hole. But if inshore winds bring in pack-ice or a cold, calm spell has caused ice to form for miles out from land, or if new ice too thin for safety lines the floe, the hunting must be done at the breathing holes. Recently formed ice on which no snow has fallen is the best for this type of hunting as the holes are then easily found without the aid of dogs. Each seal has several holes that it visits regularly; others it makes use

of less often. Usually six or seven Eskimos hunt together, and of course the more holes that are occupied the greater chance there is of making a quick kill. The longest I have ever seen a man wait over one hole is about an hour. Eskimos do not now make the elaborate preparation for a lengthy watch that they did before the rifle made floe hunting productive, or as they still do in the central region where there is no floe. The hunter stands over the hole with

his harpoon ready in his right hand and the line coiled in his left. If the harpoon head does not pierce the skull, the seal usually gives three hard pulls; then it abandons the struggle and can be pulled to the surface and shot. The hole is then enlarged with the ice chisel sufficiently to allow the seal to be pulled out on to the ice. A bearded seal may weigh 700 lb., and to hold it the hunter's strength is taxed to the utmost. To protect his wrist, he passes the loop at the end of the line over the sleeve of his *kulituk*. Occasionally, if the loop slips or the line becomes tangled, he may have his hand badly

crushed.[1] Except at Wager Inlet and occasionally at Repulse Bay, the Eskimos of this region rarely hunt on old snow-covered ice. When they do, a piece of swan's down is placed in the hole to indicate by its movement the arrival of the seal. Some Wager Inlet Eskimos use an ingenious method for hunting through the ice: an old rifle is mounted on a tripod and set over the seal hole in such a way that when the seal rises to breathe it pushes up a thin rod which releases the trigger and fires a small harpoon.

In some places where there are deep bays or islands, strong tides keep open a pool of varying size. Seals often congregate in these tide holes which are extremely convenient for travellers, since a boat is not necessary for collecting the kill. If these holes are hunted regularly however the stock of seals is soon reduced, although apparently it is replenished after a short rest.[2]

The ringed seals have their young in early April. They are born, and live for about two weeks under the snow in dens which the mother reaches through a hole in the ice. The young seals are known as "white-coats" from their fur which is yellowish-white, curly, and about 1 inch long, very different from the hair of an adult seal. The white-coats at first are quite helpless, and once the den is found, usually with the aid of dogs, it is only necessary to break in through the snow roof to secure the young seals. The mother can sometimes be lured to the opening by suspending the young on a line and dangling it in the water. It is only in the big bays that regular white-coat hunting is worth while. Cumberland Sound in east Baffin Island is one of the best places for white-coats, thousands sometimes being killed annually.[3] Bearded seals are born on the moving ice and the young are rarely taken by the Eskimos.

Spring seal hunting.—Ringed seals come up to sun themselves on the ice on the first warm, sunny days in April, and as the days grow longer and brighter, their numbers increase while the bay ice remains. Two main methods are used for hunting seals on the ice. The Eskimos of south and east Baffin Island prefer to use a screen. The hunter shelters behind this, watches the seal through the peep-hole, and moves forward only when the seal is asleep. Immediately the seal looks up, as it does at intervals varying from a few seconds to several minutes, the hunter freezes motionless until it again drops its head. The seal is usually shot from a distance of 50–100 yards. It must be killed instantly by a shot in the head or neck, or a lucky one through the spine, for if wounded, it will plunge through its hole to die or recover under the ice. The screen method cannot be satisfactorily used when all the snow has melted from the ice, for the white screen is then visible against the greener background of the ice and water pools. Neither is it very good on a bright sunny day when the sun and wind are opposed, for the hunter must approach with his shadow thrown on the screen since seals have a good sense of smell and cannot be approached from windward.

In the districts west of Baffin Island, the Eskimos favour the "crawling"

[1] An increasing number of Eskimos now shoot bearded and even ringed seals before harpooning them, but some are lost by this method.

[2] Soper, J. Dewey, 1928, p. 43. "A faunal investigation of southern Baffin Island." *Nat. Mus. Can. Bull.* No. 53.

[3] Soper, J. Dewey, 1928, p. 40. "A faunal investigation of southern Baffin Island." *Nat. Mus. Can. Bull.* No. 53.

method. A pad of bear skin is strapped to the left thigh and elbow to facilitate sliding and as a protection if the snow is wet. In late spring when there is much water on the ice, the hunter pushes himself along on a small, light sledge specially constructed for the purpose. The hunter must first show himself to the seal when almost half a mile distant, and from that time remain in full view. At first he walks slowly toward the seal, crouching as low as possible and halting whenever the seal looks up. As he gets closer, he crawls on his hands and knees, and when within 400 yards, lies flat on his side and pushes himself over the snow with foot and elbow trying at the same time to resemble his quarry as closely as possible. When the seal lifts its head, all forward movement must cease, although it is well occasionally to move the legs and head, after the fashion of a seal peering around. The hunter must show the whole length of his body and keep his head down wind in the same manner as a seal. Using this method, it is possible to get closer than with a screen. On a hot sunny day when there is a large number of seals on the ice, a good hunter can sometimes, if he uses great patience, get within 2 or 3 feet of a seal, and even cover its hole with his body, thus capturing the seal alive. A seal that has become suspicious and dived into the water will often climb back on to the ice after re-examining the motionless hunter from the water.

Crawling is useless when there is deep, soft snow both because of the difficulty of making progress and because of the obvious trail left behind. Perhaps that is why the screen is used more on south-east Baffin Island where there is a heavier snowfall. It is also very difficult to get close when the snow is bumpy, for sometimes when the seal looks up, the hunter will be fully visible on a ridge, and at others he will be almost hidden in a hollow. The screen does not give complete invisibility, but probably appears to the seal like a lump of rough ice. Success in both methods appears to depend not only on the poor eyesight of the seal, but also on its failure to remember how far distant an object was when last seen. For this reason the hunter must not approach too quickly. When the seal first notices the apparently new piece of ice or newly arrived seal, he becomes restive and wriggles toward his hole. This is the time when the hunter, before moving forward again, must be most careful to convince the seal that there is no danger. Under even the best conditions, it takes half an hour to approach within certain killing distance by the crawling method, and with a screen it is very little quicker. When several seals are lying close together some Eskimos like to shoot with a ·22, since the light report makes it possible to shoot two or three before the others are scared down. Even with a large rifle, a seal will sometimes mistake a shot for the cracking of ice. It is not often possible to approach a seal from behind rough ice, for most are careful to lie well out on the flat, especially in areas regularly hunted by man or bears. Occasionally it happens that a seal sleeps so long and so soundly that it is possible to walk up to within a few yards without taking any precautions. This is particularly true of silver jars (ringed seals of the year). When a party of Eskimos are not in great need of meat and do not wish to spend time crawling after the seal, they whip up the dogs and make for the seal as quickly as possible, shouting and yelling and preferably coming from different directions. In this way the seal is made either so scared or so curious that he forgets to go down until the hunters are within range. I have

sometimes known the seals wait to dive until the foremost dog was within a few yards.

When there is a large number of Eskimos hunting together, they may deliberately frighten the seals down, then, after occupying all the holes in the neighbourhood, harpoon them when they come up to breathe, thus saving cartridges and incidentally the loss of seals through wounding.

Summer seal hunting.—In summer hunting, seals are shot in the water from a boat or kayak. In June, July, and August, ringed seals (*Phoca hispida*) are thin and sink within a few seconds of being killed, so that they must either be killed in shallow water or when close enough to the hunter to be reached quickly. A gaff is often used for catching a seal just as it begins to sink. At Repulse Bay one Eskimo had a grapple consisting of a ball of lead to which were attached six iron hooks. Although the Eskimos do not bother hunting ringed seals much during these months, they can rarely resist shooting any that come within range and a considerable number are undoubtedly lost.

Bearded seals (*Erignathus barbatus*), except pregnant females, almost invariably sink irrespective of the season. The best method of securing them is to wound them first either by a shot in the head with a ·22 or in the body with a larger rifle, after which it is comparatively easy to come close enough to use a harpoon. Many Eskimos however prefer to kill and trust to luck to secure the carcass. Sometimes one that has sunk will be floated to the surface within half an hour by the gas forming in its stomach; at other times it will take much longer. Quite often bearded seals can be shot while sleeping on a small pan of ice. They choose isolated pans, and I have never seen more than one on the same pan.

In summer, ranger seals (*Phoca vitulina*) are usually found in or near the mouths of the rivers. They sun themselves on the top of rocks or shoals and sometimes on the beach. They sink when shot in summer. Harp seals (*Phoca groenlandica*) keep farther from the land than the ringed, and not many are killed except toward the west end of Hudson Strait.

Walrus hunting.—At Nottingham, Coats, Walrus, and Morso islands, walrus can sometimes be killed on land, but taking the district as a whole, the proportion thus killed is probably under 10 per cent. Around Native Point, Cape Dorchester, and Igloolik, most of the walrus are killed on the ice or in the water. At the latter place in the fall a group occasionally becomes imprisoned in an open pool, the ice outside being too thick for them to break through.

Walrus are still sometimes harpooned in the water, and afterwards killed by shooting. For this method, the harpoon line is usually attached to an *avatuk* so that as many walrus may be harpooned as there are harpoons, without the necessity of collecting or even killing the wounded animals. With whale boats and Peterheads it is not always easy to approach walrus within harpoon range, so with increasing frequency the Eskimos first shoot the walrus and then attempt to harpoon it before it sinks. Only about one in ten walrus will float, but even so, 75 per cent. of those killed could be secured if only one man fired from each boat, the others being ready to bring the boat quickly to the walrus and harpoon it. Actually however everyone wants to shoot and usually does, each selecting his own and probably a different target, so that five or six walrus are killed or wounded without any one being ready

to harpoon them. If not killed instantly, those shot on the ice fall into the water in their struggles, and even when dead they frequently slide off, especially if there is any swell. Sometimes walrus can be shot in shallow water and collected at low tide. The Southampton Eskimos say that this is the method they use at Coats Island. Undoubtedly walrus are the most dangerous animals hunted by the Eskimos, but the fear shown by some, even when hunting from a Peterhead, is surprising for a people whose ancestors hunted them in flimsy kayaks.

Whale hunting.—White whales and narwhals have the same habits and are hunted in the same manner. The white whales outnumber the narwhals in Hudson Strait and Foxe Basin, and in Hudson Bay the latter are very rare indeed. Both sink when shot, and as they only rise to the surface for a short period and are always on the move, it is difficult to choose a vital spot. The Eskimos usually harpoon them before shooting. As they swim in straight lines and break surface frequently when chased, this is not so difficult as might be supposed. In some districts nets are set in likely places, for example, at points and at the entrance of bays. (Seals may also be caught in these nets. At Pangnirtung, a net is set in the narrow crack which divides the fjord ice from the main ice of Cumberland Sound. This is the only place personally known to me where a seal net is used in winter.)

Both white whales and narwhals can be driven by motor boats and gunfire on to a shallow shore where they will be stranded by the receding tide. Left to themselves, the Eskimos rarely use this method, which requires organization and the cooperation of several boats, but the Hudson's Bay Company usually organizes a hunt in Cumberland Sound, east Baffin Island, sometimes over five hundred white whales being killed in a single drive. In the fall Eskimos sometimes harpoon both species as they swim under and break through young ice just strong enough to bear a man. Like the walrus, they occasionally become marooned in a small water hole when the seaward ice becomes too thick to break through. They are rarely, if ever, killed at the floe before April.

Only the Aivilik Eskimos of Southampton Island still hunt the Greenland whale. They use the same equipment that was used by the whalers at the beginning of this century. In the last few years they have killed three in Evans Strait, but they had no means of saving more than enough oil for their immediate needs, and the chief value of the carcasses appears to have been their attraction for foxes, several hundred, albeit with rather greasy pelts, having been caught alongside them.

Caribou hunting.—The only difference between the way Eskimos normally hunt caribou and the way the sportsman of more southern climates stalk a deer, is that the Eskimo's object is to kill the whole herd which may number fifteen or more. This can be done only by approaching within certain range before firing, shooting the leading animal, and always remaining unseen, so that the caribou will not be able to make up their minds which way to run. In cold, calm, winter weather, caribou appear more wary than in summer,[1] and the great distance that the sound of a man's footsteps on the snow will

[1] Manning, T. H., 1943, p. 50. "Notes on the mammals of south and central west Baffin Island." *Journ. Mammalogy*, vol. 24, No. 1.

carry under such conditions adds to the hunter's difficulties. In winter when the Eskimo is travelling by dog-team and comes suddenly upon a herd, he whips up the already excited dogs and gives chase. Although the caribou are easily able to outstrip the dogs, they will run for about half a mile only and then stop and watch the approaching sledge until it is within 100 yards or so, when the performance is repeated. Not many caribou are killed this way, as it is hard to shoot accurately from the moving sledge, and unless there are two men, to jump off would mean losing the dogs.

Fishing.—The Arctic char (*Salvelinus alpinus*) are the only fish of importance to the Eskimo. Some of these spend the whole year in the lakes, others go down to the sea in the summer. In the fall, fish nets are set out under the lake-ice by cutting a series of holes and pushing a long pole from one hole to the other. Attached to this pole is a line by means of which the net is afterwards drawn along. When it is required to haul in the net for fish, the line is left under the ice so that the net can readily be re-set. Care must be taken to see that the net is properly sunk so that as the ice thickens it will not freeze in. A fish net can be, and often is, set out even in mid-winter when the ice is 4–6 feet thick. Cutting eight or nine holes through this thickness of ice is not such a task as it sounds, and with a good, heavy ice chisel, it can be done in a couple of hours. It is little trouble to open the two end holes to draw the net, especially if they are covered with snow and the net is visited regularly. When the Eskimo has his family living with him at the lake, the net is drawn at least every other day, the work sometimes being done by the women or children. If however the family is living at the coast, the net may be visited only once in two or three weeks. Whatever the air temperature, fish left dead in the water will decompose with surprising rapidity. These are used for dog feed.

Before putting out the net, the site is tested by jigging a small piece of ivory or bright metal in the water to attract any fish in the neighbourhood to the opening. In the same way fish are attracted for spearing. When a family is living near a fish lake, they augment the net catches by spearing, and in the fall, when the ice is thin, travelling parties stop at well-known fish lakes on the route to spear a few fish. In some brooks one sees old rock traps in which fish caught by the receding tide were speared. At the present time these traps are rarely, if ever, used, and spearing is confined to that done through the ice in fall and winter. In summer, fish are caught in nets set in shallow water close to the shore. The inner end may be just above or just below the low-tide line. The end of a point makes the best place to set these nets, as the fish cut across the small bays. If there is any ice, a careful watch has to be kept on the net, and it is necessary to take it up in stormy weather if it is in an exposed position. No fishing is done in the lakes during the summer.

Bear hunting.—In summer, bears are often shot in the water, where, although fine swimmers, they cannot escape from a boat. Only the very thin ones sink, and even then but slowly. In summer time when sighted at a distance, they are stalked; occasionally it is possible for a man to run down a fat bear that has recently fed. When there is snow on the ground, they are usually seen when the hunter is travelling with a dog-team, for in winter Eskimos rarely walk unless they are hunting caribou. Once the dogs have seen or smelt a bear, one or two are let loose. These rapidly overtake it and hold it at bay.

At a few hundred yards distance the hunter slips or cuts the traces of the remaining dogs. At first they run in and out, continually nipping at the bear's heels, but after a few minutes they stand back in a ring and the hunter can get a clear shot. At times a dog is badly torn or killed by a bear, but this is remarkably rare. It is not uncommon for a bear attracted by the smell of meat to walk into a camp where it is immediately surrounded and held by dogs until an Eskimo, disturbed by the noise, comes out. There is no danger and little sport in shooting polar bears with a modern rifle.

Trapping.—In country that is much trapped, wolves are too wary to be caught often. A method of killing them, occasionally adopted with success, is to set an old rifle in a disused snowhouse, aiming it at a piece of meat which is attached by a cord to the trigger. At one time when wolves were very troublesome around their trap lines, the natives of Southampton Island tried placing old razor blades, broken glass, and sharply pointed baleen in pieces of meat and fat. The baleen was bent, and bound with sinew which, on being digested, would allow it to straighten out and pierce the walls of the animal's stomach. So far as I know, these attempts were unsuccessful, for although the bait disappeared, no wolf carcasses were found. Occasionally wolves come within rifle range. The last wolf on Southampton Island was killed in 1937. They are no longer found on the south coast region of Baffin Island or on the east side of Melville Peninsula.

Traps for foxes are on a chain some 2–2½ feet long. This is fastened down either by means of an iron spike driven into the frozen ground, or by rocks. A block of snow 1½ feet square and some 6 inches high is cut, and a hollow made in the centre for the trap. Then a further block of snow is placed over it and scraped thin enough to be broken by the fox's weight. A piece of bait is put close to the far end of the spring, sometimes being weighted down by a rock. If the traps are set by a cache, they are often simply placed uncovered on a rock. This is the way many of the east coast Baffin Islanders regularly set their traps; these people are poor trappers. The white trappers on the west coast of Hudson Bay shovel a heap of snow about 4 feet high and place the trap on top. This method is not used by the Eskimos. It has the advantage of placing the trap above the ground drift where it is less likely to be drifted over or for the crust to be cut away by the abrasion of flying snow. Placing the trap in a snow block as the Eskimos do is for the same purpose, but while much quicker, it is less satisfactory, as it only raises the trap a few inches.

An Eskimo trapper has an average of thirty or forty traps. These he will set out from a quarter of a mile to 1 mile apart, the distance varying according to the number of traps he has and the area he wishes to cover. When visiting their traps, Eskimos usually travel in two's or three's; as many as five, each with his own sledge, may set out together. This is in sharp contrast to the habit of the white trappers, and obviously entails much duplication of effort, for although there is a considerable advantage in two people travelling together, very little is gained by adding a third, especially over a short, well-known route. Those Eskimos having sons of between ten and eighteen years are usually accompanied by them. Sometimes a father and married son will take a single team between them, particularly when they think they may meet caribou.

The normal round of Eskimo hunting activities throughout the year

The big event of the Eskimo year is the arrival of the annual supply ship, the R.M.S. *Nascopie*, or on the mainland coast, the motor schooner, *Fort Severn*. This may take place any time between mid-July and late September according to the district and the route taken by the ship. Almost every Eskimo able to make the trip in to the trading post sets out with his wife and family to meet the ship, timing his arrival by the approximate date given by the post manager. He has the pleasant prospect of being able to replenish (on credit adjusted to his ability as a trapper) his vanished stores of cartridges, flour, tea, and tobacco. While at the post he is given a small ration to compensate for the hunting time lost and for the work of unloading supplies for the post. Two or three days after the ship leaves, all the Eskimo families return to their homes, and most of those who live over 50 miles distant will not again visit the post until trapping has provided them with foxes for barter.

If the Eskimos are back at their camps by the beginning of August, the Arctic char will still be trimming the shore. Most families have one or more nets, and for a time may be able to obtain enough fish for their immediate needs. Eight fish, or 30 lb. per net per day, is all that can be expected at any average spot at this season, and the catch will be much reduced before the end of the month when the fish collect at the river mouths preparatory to ascending to the lakes for the winter. If the camp is near such a river, good catches may be made at least as late as September 10. Caches that can be used for both men and dogs during the winter may be put up, but it is only in exceptional circumstances that these are large enough for more than a month's continuous feeding. As for instance at Gore Bay, Melville Peninsula, in 1936, when a drought prevented the fish from getting beyond a certain point in the stream, and several tons were caught by five families. For the majority of Eskimos, fall fishing is only a side-line to the more serious business of preparing a supply of seal or walrus meat for the winter, although it gives them a welcome change of diet for very little trouble. A few eiders killed from the large flocks of fat and nearly flightless birds that are feeding out at sea during August and September make another change of food.

Towards the end of August, the ice bringing the walrus arrives at Native Point and Nottingham Island where the Southampton Island natives, and those of south-west Baffin Island and north-west Quebec respectively, make most of their hunts. The Cape Dorchester Eskimos get a considerable number of walrus at least as early as July, while at Igloolik, which is by far the best walrus district, the major hunts are made in the spring and fall. When there are no walrus at Native Point,[1] the Southampton Island Eskimos may go to Walrus or Coats Islands. A few of the Chesterfield Eskimos, and the coastal Eskimos to the south as far as Eskimo Point, hunt at Morso Island in Mistake Bay. In order to avoid disturbing the walrus more than necessary, the R.C.M.P. arrange for everyone, Eskimo and white (the R.C.M.P. from Baker Lake, Chesterfield, and Eskimo Point, as well as the Hudson's Bay Company's staff, mission, and white trappers), to make a simultaneous hunt, usually in

[1] In 1941–42 and 1942–43, a party of about thirty-five Eskimos wintered on Coats Island.

September. In spite of these efforts, walrus visiting Morso Island appear to have decreased in number during recent years.

Not all Eskimos are able to obtain a supply of walrus meat for the winter. Some camps, such as those around Repulse Bay and Wager Inlet, are too far from the areas to which walrus resort; others, though near enough for Eskimos who own Peterheads, are still too distant for those who have whale boats which on a trip of 30–40 miles out to sea can carry only two to three walrus.[1] Eskimos thus situated must depend on ringed or bearded seals and an occasional white whale for their winter caches which will usually be small.

Boats are beached for the winter between the end of September and the end of October, according to the district and the mildness of the year. For two weeks after this, there is an interval when the ice has not made or is not strong enough for hunting, and at some camps where there are no sheltered bays, the period is even longer. This is often a time of enforced inactivity for the Eskimos, though some make trips inland to a fish lake where they spend a few days setting out nets and spearing fish through the ice. Later they return to draw the nets, and when more snow facilitates travelling, a few take their families inland, and remain at the lakes as long as they have seal oil for their lamps or are able to get sufficient by occasional hunting trips to the coast. On Southampton Island, special journeys are made in October to hunt bears on the Foxe Channel side of the island, but I have not heard of any such journeys elsewhere.

Once the ice on the bays will bear, the hunting of seals at their breathing-holes begins. On mild days in the fall, seals lie up on the ice, but little hunting of these can be done at that time of year as young salt-water ice is too wet and slushy for crawling and not white enough for successful use of the screen. When the ice first makes, the floe edge is too thin for close approach, but after a strong blow, it breaks off and floe hunting begins. From this time onward until May when the ringed seals begin to come up on the ice in numbers, seal hunting is continued in the manner described in the previous section.

The official open season for Arctic fox (*Alopex lagopus*) is from November 1 to the end of March, but Eskimos who are beyond supervision do not take up their traps until the end of April, the foxes being in prime condition until then. It is safe to say that if it were not for the Arctic fox there would be no trading posts more than 100 miles north of the timber line. The posts buy a few weasel skins accidentally caught in fox traps, in some places a few wolf, wolverine, and seal skins and a little ivory, but 90 per cent. of the trade is in fox pelts. The importance of this animal to the Eskimos is therefore easily understood.

The amount of time spent tending traps varies greatly both with the individual and the season, as of course does the amount of fur taken. Some men who are good hunters, do not take a great interest in trapping; others who have not secured sufficient dog food during the summer and fall either because they are poor hunters or through laziness or bad luck, have to spend almost all winter seal hunting. In good years a capable trapper will get a hundred,

[1] The increasing number of Eskimo-owned Peterheads, which are unsuitable for seal hunting and enable more Eskimos to reach the walrus grounds, is undoubtedly contributing to the destruction of the walrus at the more accessible places.

or in very exceptional cases, two hundred, foxes; in a poor year, about thirty. A poor trapper may take less than a tenth of this amount.

Besides being controlled by the amount of time any individual may have free from his hunting for food, the visits to his traps are governed by the weather, the number of foxes, and the presence of wolves, coloured foxes,[1] or wolverines, which may eat the foxes in the traps. The weather is a factor of importance because a big drift puts many of the traps out of order, and because in mild weather a fox often succeeds in working his foot off and escaping. In cold weather the latter rarely happens, as the leg in the trap rapidly freezes and the fox dies in about three days. The abundance of foxes is also a consideration for two reasons: first, the Eskimo is more anxious to visit his traps if he feels sure of a good catch, and secondly, when there is a large number of hungry foxes, they will eat the dead in the traps.

By the end of February, it is only a few of the most provident Eskimos that still have caches of dog food remaining from their fall hunts. More time must therefore be spent seal hunting, and prolonged bad weather or unfavourable ice conditions may cause hardship. A similar hand-to-mouth existence continues throughout the spring and summer, but this is due to improvidence rather than scarcity. Walrus are quite often heard among the pack-ice in at the floe edge, especially in late February and March, but it is difficult to get out to them, and very few are killed. Early in the latter month, bears begin to come out of hibernation, and a few of these are killed, especially on Southampton Island. A few seals come up on the ice in early April, but they stay up only a short time and are easily scared. West of Hudson Strait it is not usual for seals to become sufficiently numerous before mid-May to mark the end of winter and the commencement of easy living.

For the Eskimos, May and June are the happiest months of the year, with long days, fine weather, ample food, and probably some tea, tobacco, and flour still left from the winter's trading. In many districts this is the time when caches of dog food and fuel for the following winter could best be made, but the Eskimo has forgotten his trials and the hardships of the preceding winter, and prefers to spend his spare time basking in the sun, playing ball, or doing odd jobs of no importance.

Ducks arrive at the floe in May, but they are rarely killed before June, when they move inland to the pools and small lakes formed by the melting snow and ice. Then a few, together with a small number of geese and an occasional swan or crane, will be shot. A little later, some duck, gull, and goose eggs are collected. These depredations against bird life, though violating the letter of the law, are infinitesimally small when compared with those made by southern sportsmen.

There are usually some small harbours clear of ice in July, and those boats which are too heavy to have been used from the ice edge earlier, can be put permanently in the water. By the middle of the month, most of the ice has cleared away from the coast, and nets are put out for the fish which are just

[1] Coloured foxes (*Vulpes fulva*) are exotic to Southampton and Baffin Islands, and on the mainland west of Hudson Bay their normal limit is the Chesterfield district. Coloured foxes will kill and eat live Arctic foxes in traps. They are considerably harder to trap than Arctic foxes.

beginning to leave the mouths of the rivers to follow around the coast. The first few catches are usually the heaviest, and some fish are dried in the sun although rarely more than sufficient to last a few days.

Mosquitoes are very troublesome on fine days during the last three weeks of July so the Eskimos spend much of their time hunting from their boats, often taking their families out with them. Bearded seals are shot in the water, and where there is loose pack they are more likely to be found sleeping on an ice-pan than they were earlier in the year. They rarely come up on the attached bay ice, and have their young also on the moving ice. Except in shallow water it is a poor time to shoot ringed seals as they almost invariably sink and are lost.

So far, I have made no mention of caribou, for in the greater part of this area they have become so rare as to be no longer hunted at specific seasons. One Baffin Islander living on Southampton Island saw his first caribou in 1937, when he was in his twentieth year. At Southampton Island, Foxe Peninsula, and Melville Peninsula, caribou are only hunted when trapping is over and there is ample dog food available for an inland trip, or when tracks are seen crossing a trap line. At these places therefore caribou are usually killed in winter or spring when the skins are useless for clothing. Wager Inlet is an exception. There, caribou are still fairly numerous in the summer, and some occur throughout the year during the winter. Regular caribou hunting trips are made, and at least some of the natives go inland to hunt during the summer. Another place where caribou are still fairly numerous is west of Cumberland Sound, but the Baffin Island natives pay less attention to caribou hunting than those north-west of Hudson Bay, and the milder weather in that area makes skin clothing less necessary. At Chesterfield, caribou hunting is done in the fall with varying success, and many of the Igloolik natives have recently moved to the east of Foxe Basin where in 1938–40 caribou were rather numerous.

Percentage by weight of food animals secured [1]

	Southampton Island			*Wager Inlet*			*Repulse Bay District*		
	Winter	*Spring*	*Summer*	*Winter*	*Spring*	*Summer*	*Winter*	*Spring*	*Summer*
Total ..	35·0	15·0	50·0	35·0	20·0	45·0	35·0	25·0	40·0
Walrus ..	1·3	1·0	35·0	—	—	10·0[2]	—	1·0	2·0
Ringed Seal	23·0	10·8	5·0	20·0	14·0	10·0 (?)	20·0	13·0	14·1
Bearded Seal	10·0	2·0	6·0	2·0	1·0	9·0 (?)	6·0	5·8	15·0
Harp and Ranger Seals	0·2	—	0·3	—	—	—	—	—	0·3
White Whale	—	1·0	3·0	—	—	2·0 (?)	—	—	3·0
Fish ..	0·4	—	0·5	3·0	—	1·0	4·0	0·1	5·0
Caribou ..	0·1	0·1	—	10·0	4·9	12·9	5·0	5·0	0·5
Birds ..	—	0·1	0·2	—	0·1	0·1	—	0·1	0·1

[1] A considerable amount of imported food, largely flour and sugar as well as tea and coffee, is consumed, but a discussion of this is outside the scope of the present paper.

[2] Usually killed outside the inlet.

In the above table Southampton Island excludes natives wintering on Coats Island; and Repulse Bay District excludes the western side of Rae Isthmus. Winter is taken as the time between October 1 and May 15; spring from May 15 to July 1; and summer from July 1 to October 1. The figures

are estimates only based on general observations. Those for Southampton Island are the most reliable owing to my longer experience there. A table for Foxe Peninsula would rather closely follow that of Southampton Island with perhaps a 10 per cent. increase in bearded seals. In one for Igloolik the percentages of walrus would be considerably larger at all seasons than that for Southampton Island, and if the hunts of those natives living on the north-east side of Foxe Basin were included, the winter caribou percentage would be fairly large.

A JOURNEY THROUGH THE QATTARA DEPRESSION

D. C. M. MATHER

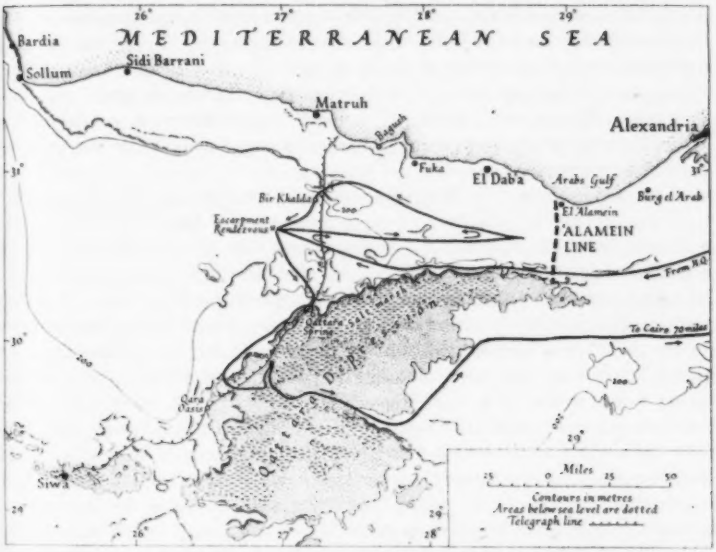
DURING the second year of war in the Western Desert and Libya, we had found it profitable to make long-distance raids on the enemy's exposed line of communication. Benefiting by the invaluable experience of the Long Range Desert Group, who by the time we had arrived on the scene were already veterans in desert travel, we endeavoured, with a good measure of success, to make wide sweeps behind the enemy lines, suddenly attacking exposed landing grounds and destroying aircraft on the ground. At first we had worked exclusively with the L.R.D.G., they had been our guides and had carried us to and from our objectives with unfailing accuracy. Now in the summer of 1942 we attempted our first large-scale operation with our own transport and navigators.

In June the war situation in the Middle East was as bad as it ever had been. After the fall of Tobruk the Eighth Army had retired to the 'Alamein line, a line 40 miles in length bordered by the Arabs gulf in the north and the Qattara Depression in the south. Here the remnants of the Desert Army were endeavouring to make a final and desperate stand. It was decided that our raiding force, under Stirling, should make a series of attacks on aerodromes behind the 'Alamein line working from a base 100 miles behind the German front. Here we would stay and operate for as long as our supplies held out. When they were finished we would return again to the Delta. For this operation we had about ten officers and one hundred men. We used jeeps mounted with machine guns, and 3-tonners to carry all our supplies of petrol, water, food, and ammunition. They would form our floating base until their loads were exhausted. Armed with maps, which in case of defeat at 'Alamein would enable our party to travel south-west to Kufra and Chad, south to the Sudan, or east into Sinai and Palestine, as the situation demanded, we left Cairo one June evening.

Travelling west from Eighth Army H.Q. on the Alexandria–Cairo road, we passed north of Wadi Natrun reaching the base of the 'Alamein line after a day's journey. Having passed safely through the line we hugged the lip of the Qattara Depression, occasionally following an indistinct track marked by palm leaves. The bottom of the Depression could not be seen, only a descend-

ing series of cliffs and boulders dropping sharply until their outline was lost in a shimmer of pink. A further two days' travelling brought us to a point about 30 miles north of the Qattara Spring, 50 miles from the enemy-controlled coast at Mersa Matruh, and 100 miles due west of the 'Alamein line. Here was a long low escarpment which offered good cover for our thirty vehicles, and this we made our base for operations.

For fourteen nights we attacked almost nightly the enemy aerodromes lying between Matruh and Dab'a. At the end of these two weeks our supplies of vehicles and ammunition were exhausted so, leaving a small retaining force of thirty men at the Escarpment Rendezvous, the remainder returned to Cairo. A fast party of four jeeps under Stirling managed to force their way



down the camel track at the Qattara Spring, drop into the Depression and reach Cairo in two days. The heavy party travelling on top of the Depression Escarpment again, filtered through the 'Alamein line and reached Cairo intact in three days. Two hectic days were spent refitting and collecting new vehicles, then the new force of about twenty-five jeeps returned by way of the Qattara Depression back to our rendezvous.

After a busy day's preparation we delivered our final aerodrome attack. A 50-mile night drive brought us to our objective near Fuka; here we spent twenty minutes destroying the Stukas, Messerschmitts, and Junkers which lay thick on the ground, and then melted again into the desert. As we had destroyed ninety enemy aircraft during these four weeks, it was decided that only one more operation, of a rather different nature, would be undertaken

Four jeep patrols, each consisting of two vehicles, were to cover the rear of the 'Alamein line with the purpose of strafing the soft-skinned convoys

which brought up supplies to the enemy forward troops. From our escarpment R.V. lying 100 miles west of the fighting line, it would require two nights for the outward journey, two nights of operating, and two nights for the return. All our parties reached their objectives, but this time our luck had turned and although we spent two nights driving undisturbed amongst their tank leaguers, we found no targets that would justify revealing our intentions and jeopardizing our chances of a return visit in more fortunate circumstances.

This part of the Western Desert which we had grown to know so intimately, an intimacy which had become almost possessive, was a wide flat land. To the north was the Mediterranean; to the south there was the Qattara Depression. We knew the land to the north as a rest area. We knew the Depression as a bolt-hole, an alternative route to the Delta, and security; it was hot and treacherous and a little overpowering in its dimensions. The land between seemed to contain three main escarpments. There was the main coastal escarpment dropping down to the sea; 15 miles farther south another escarpment of perhaps 50 feet, and 15 miles farther south again the third escarpment of the same height. The land beyond this rose gently until it reached the lip of the Depression, where it dropped steeply for 400 feet into the great bog and salt marsh.

Most of this country we had only seen by moonlight, for travelling in daylight was an open invitation to prowling Macchis and Messerschmitts. There was very little chance once one's dust-cloud had been seen; then it was usually one jeep against one fighter, and the latter always won. Most of us had experienced that unpleasant individual type of strafing. Many of us had lost our vehicles once or twice over and been faced with a waterless journey on foot, and a few had lost their lives. So most of our knowledge had been gained from maps and night driving, but we knew that these three escarpments began at the great cliff above Sollum, now a heap of rubble, and as they ran eastwards gradually fanned out and dipped to the south until they were lost in the gentle country south of Burg el 'Arab. The land between them was flat and occasionally intersected by shallow wadis. The coastal belt had been a battle ground, it stank, and the camel scrub was trampled down so that the only cover by day was in the heavy shadows of burnt-out vehicles and tanks. Farther south it was more healthy for us. There were shallow depressions and small patches of camel scrub, never growing higher than 2 feet, but sufficient cover for a camouflaged jeep. We spent many burning hours lying, unmoving, in this camel scrub unable to shelter from the blazing sun, waiting until the evening brought relief and we were able to drive on under cover of darkness.

On the fourth day out my little party of two jeeps and three men lay snug and concealed in a small wadi running down from the central escarpment. Although the escarpment was only 30 feet high at this point our wadi had shallow caves and small bushes in which we could hide ourselves and our vehicles, remaining concealed from the air or from ground patrols. We had taken good care to obliterate all tracks approaching our hideout, crawling down the wheel marks on our hands and knees and pushing back the sand into the furrows, so that no shadows would be cast which can be so quickly recognized from the air.

The previous day we had been disturbed by a Senussi, who, leaving his caravan out in the open plain before us, walked straight up into our wadi as though he expected someone to be there, but receiving no greeting from us he turned about and retraced his steps. We wondered a little at this, for there must have been about three hundred camels out in the plain below, and being only 12 miles behind the front line it was an unusual sight. Possibly they might be employed by the Germans for some obscure transport purpose, for they certainly would not work for the Italians, but it was strange, for since the fighting had started most of the Senussi had moved either south to the oases of Siwa, Giarabub, or Kufra, or west up into the Jebel of Cyrenaica. Only a few independent souls stood on the coastal road as the retreating armies passed to and fro, holding up eggs for whoever had time to buy. But generally we had found them strongly pro-British and anti-German, with no remembrance of their alliance of 1915.

Our suspicions were well-founded however, for towards the afternoon of this day our small wadi was visited by a column of German tanks and guns who made circles round our hideout, even sending stones rattling down the cliff sides, and although they approached to within 50 yards of our camouflaged jeeps they failed to see us. It must have been some trick of the sun that kept us invisible. When evening came we were glad to get away and travel all night under a waning moon.

The following day we lay up under what we imagined to be the southernmost escarpment; it only rose to a height of 20 feet but it provided adequate cover and we were not spotted by hostile aircraft. We passed under the line of telegraph poles leading from Bagush to Siwa early the next morning after a fast night drive. Luckily our navigation had been accurate and I recognized the spot as Bir Khalda. From here it was only 20 miles to the Escarpment R.V.

It was good to be driving up the familiar cliff side again, sending up clouds of fine dust into the morning air, and to find that the cave still seemed to be inhabited. We ran our two jeeps up the sand-bank and into the cave, making thunder in its eaves and awakening the sleepers. We found Sandy Scratchley in the cave and he greeted us with bad news. The German prisoners that we held had escaped, patrols were out after us, and the base of the 'Alamein line had been sealed by the enemy and was impassable. Now that our work was completed we had orders to return immediately. The only possible route left was down into the Depression and across the marsh, allowing that the tracks and passes had not been cut by the enemy.

We had been ten days and nights without sleep, but after a breakfast of fried sausages and tea and a few hours of discussion, we prepared to depart. There was a pass leaving the high plateau between the Qattara Spring and Qara Oasis. Both these watering places lay in the western side of the Depression. The first was approached by a precipitous camel track impossible for heavy vehicles; the second by a long but navigable pass. We had information that Qara was held by the Germans, but we did not know about Qattara. The pass itself left the plain at a point just above Qattara, so that it was possible that the enemy might attempt to block it. Every moment the supposed force that was on our trail grew in size: the latest message that we received on our

11-set said five hundred strong, adding aircraft also. But to get back to Cairo we must descend into the Depression by the Qara Pass, and enemy or no enemy that must be our first objective. Scratchley had visited it by daylight a few weeks previously and he reckoned that he could recognize it again by night. It lay on the Bagush–Siwa telegraph line and quite near there was a small pile of petrol tins. If the moon had not been in its last quarter it would have been easy.

Before we left we had to pick up Steve Hastings, who was escorting two 3-tonners back from a disused landing ground near the coast. The previous night our main party had lit a flare path and brought in two Bombays to land there. The landing was a great success. The Bombays dropped petrol and picked up seventy of our men, and then returned to Heliopolis aerodrome outside Cairo. The remainder of us, about thirty strong, were to bring back our fifteen vehicles, a battered collection of jeeps and 3-tonners, to the Delta.

When Hastings came back the sun was well up, and he had been troubled by a low-flying enemy bomber which had circled over him several times, but he could not be sure that he had been spotted. Although it was daylight we decided to risk it and push east along the escarpment to get out of this unhealthy area. It was fortunate that we did this for we heard later that an enemy force had visited our old R.V. a short time after we had departed.

This escarpment faced south-west, and so by following it along we were travelling south-east and towards Qattara. It was the first of the steps dropping down towards Siwa Oasis, another depression, but not as deep as that of Qattara. With our fifteen trucks spaced out at intervals of 200 yards we crept along the broken cliff side, moving slowly to keep the dust down, and stopping frequently to listen for hostile aircraft. We had one alarm as a bomber passed very high over us, but as we had stopped in time it could not see our dust clouds. At midday we halted and camouflaged all the vehicles. We stopped here until dusk and rested, but could not sleep for the flies and heat.

There was a high barren knob above our halting-place, and after lunch I climbed up this to take my turn as watch. The view to the south was almost limitless, but shimmering in the midday sun it was difficult to pick out any landmarks. Somewhere there was the place where the ground must sink to the Depression, and farther to the east was the route we had taken several weeks before to collect water from an L.R.D.G. Heavy Section. Quite close to where we had stopped on that occasion we had found some old pots lying under a cave. They were only fragments and we thought of "the lost army," but as we lay close to an old camel route they were probably no more than discarded Arab water jars. That was about the only find that we made during our journeys, in fact we took little interest in such things, being too concerned with our own immediate problem of living. Under this same escarpment we had found marine fossils embedded in the eaves of the caves, but no one questioned the reason for their being there in the middle of the desert. I often wonder that we did not take more interest in the nature of our surroundings, and afterwards reading papers in the *Journal* on "Problems of the Libyan Desert," I cannot help feeling that we would have been delighted to have known that there existed other problems in the Libyan Desert besides our own.

When I had scrambled down from the knob at the end of my watch, I

walked along to the cleft in the rocks where Scratchley was resting, and together we drank tea and made up a message to Cairo demanding a petrol dump to be made for us at Egyptian Post, a point on the eastern side of the Depression, for even though we had had supplies of petrol landed for us by the Bombays the previous evening, it was only enough for us to get half of the way back. Any alternative route round to the south of the Depression was out of the question, even the hard surface track following the great northern escarpment of the Depression was not feasible. On the 1 : 500,000 map a red dotted track was shown cutting straight across the central bog. There was a kind of bridge, the Qara Crossing, we had heard, and vehicles had passed that way before.

About an hour before sunset we risked moving and filling up the vehicles from the petrol 3-tonners so that we could be ready to start just before sunset and get at least an hour of travelling in the half-light, for the country beyond looked broken. Quite suddenly, when all the vehicles were out in the open, four Stukas appeared flying at 300 feet. We all froze, and as they passed over us they simultaneously let off a burst of machine-gun fire, not at us but into the cliff beyond.

The moon did not rise until 2 a.m., so that our first few hours of driving were very difficult. However there was a certain amount of light reflected on the surface of the desert by the stars. After two hours of driving we hit a soft patch on the upward slope of a ridge. Leaving the vehicles to extricate themselves with sand-channels and mats, we explored along the ridge in our jeeps and after an hour found a firm crossing. No sooner had we surmounted this obstacle than we fell axle deep into a wide field of soft sand, again bordered on the east by another impassable ridge, and we were forced to push on north in the opposite direction of our bearing until we found a gap. Some of the bolder drivers had taken it at a dash and, obeying the maxim of stopping only on hard going, had disappeared. Others, after extricating themselves, had followed separate veins of hard sand in all directions, so that it was not until midnight that we were able to reassemble the party. It was essential that we should reach cover in the Depression before daylight. Our first guide was the Bagush–Siwa telegraph line, and we hit it very soon, but on following it in the right direction for a few miles we were disappointed to find that the poles lacked wire and very quickly petered out altogether.

We took an eastward bearing and hit the main line after 2 miles, following it down on a good track until we came into the area of the Qattara Spring. Here we found the camel track to the spring below, where it disappeared over the edge of the Depression; then we cast about, carefully quartering the ground for a track leading south-west into the Qara Pass. After searching for an hour, with an uncanny sense, Scratchley found the spot, and very soon we were plunging down into a gorge enclosed by great rectangular rocks precariously balanced, and our engines echoed noisily until we passed out into a gradually descending open plain below. We followed this good track for the rest of the night, often travelling at 30 miles an hour, frequently stopping and changing drivers as they fell asleep at the wheel, until at dawn we turned left off the track towards hills formed of huge up-heaved rock slabs under which we could drive our jeeps and 3-tonners into safety.

That morning we were able to have some excellent tinned American bacon for breakfast and plenty of biscuits and jam which had been dropped for us by the Bombays. We had done 70 miles during the night and were quite satisfied. The main problem that lay before us now was finding the Qara Crossing the following night. Later in the day a hostile fighter patrol warned us that we were wise to lie so carefully concealed. The track we had been following down went direct to Qara, from where there was apparently a good track to the Crossing. Unfortunately we could not pass through this enemy-occupied oasis, which was a pity as the Sheik of Qara was an old friend of some of us. We decided to leave the track about 15 miles north of Qara, swinging south-east to cut the track running from the oasis eastwards to the Crossing, which we hoped would lead us safely across the bog.

By the starlight we only got a vague impression of the surrounding land. Our route descended gradually amongst broken country, and as I was navigating I had to concentrate wholly on the wheel marks I was following. It was very tiring and exacting work. After about 50 miles we swung south-east passing over a flat gravel surface scattered with stunted acacias giving, in the gentle light, a rather park-like appearance. This scanty vegetation showed us that we were at the bottom of the Depression. At about 3 a.m. the waning moon began to rise, and we hit the track at exactly the correct mileage. We would have to hurry if we were going to get out of the flat bog by daylight, but we stopped to check our bearings, then drove on for 4 miles until we lost the track and, on turning round we found, to our surprise, that we were missing ten vehicles. The drivers had all gone to sleep at the last halt, and even the cries of "start up" and the noise of engines had not awakened them. After an hour's search we found all ten of them standing motionless in the desert, with drivers slumped over their wheels. The situation was getting critical. There was only an hour until daylight, and we were in the middle of the Depression with no cover within miles. We drove on fast for a few more miles, but after two bad collisions, we gave up the attempt, and raced back to the escarpment, where we could shelter for the day. In the dim light of dawn the great cliff towered before us, but it was more than two hours before we plunged into its deep shade. Here, lying beneath the 400-foot cliff, we spent our second day. We must have been about 20 miles from the Qattara Spring. It was intensely hot, but we felt secure from any enemy planes that might try and attack us. It was pleasing having cheated them so far, for there was no doubt that they had been after us for the past three weeks. From where we lay under boulders and wedged between rock clefts, we could see to the east a firm but broken crust, to the south-east a flat gravel plain, but no sign of bog or marsh. However we thought it would be wiser to retrace our old tracks of the night before until we came to the main Qara Crossing track. From here we could follow it slowly and carefully until we had passed over the bog.

That night we made our second attempt to cross the Depression. We followed the beaten track carefully until it became only a few wheel marks. Then we found ourselves following a single wheel track only, very difficult to see by starlight, and so cast left and right to locate the main route once again. A few miles more and it petered out altogether. Then we found ourselves

travelling over a rough rocky surface for about 200 yards. At the end of this lay a hard salt crust with a quaking bog beneath. We sent our four jeeps to the four compass points. Three returned and reported bog on all sides, the fourth with all its kit sank beyond recovery bonnet deep into the bog itself. Again only one hour remained till daylight. As the surrounding surface was hard rock we were unable to trace the route we had come by, and so we seemed to be stranded. Then we found an outlet. It was undoubtedly bog beneath, but there seemed to be a fairly stout crust. It might lead us into a further bog, we had no idea what lay beyond, but it was our only chance. For 300 yards the surface held even our heavy trucks. Then we came to a dyke of soft mud, only about 10 feet across. We put tarpaulins, steel sand-channels, sand-mats, and more tarpaulins over this, and each vehicle charged it at top speed. It had to be done very quickly because the stationary vehicles on the near side soon began sinking slowly through the crust, in fact we were too late with our last 3-tonner, for when its turn came to take the jump it had sunk up to the axles and soon the tail board began to disappear. We abandoned it and hurried on to the next dyke. This we bridged in a similar manner, and a third, and just when we were beginning to think that to continue was foolhardy and to return was impossible, the ground began to steady. The upper surface became spongy, but there seemed to be a firm foundation beneath, and shortly we reached a wide flat gravel plain. We halted for a few moments to get our direction; took a bearing on a low constellation of stars, switched on all our head-lights, and raced at 50 m.p.h. towards the north-east. The dawn was just beginning to break, the billiard table surface lasted, and we covered 30 miles in less than an hour. We raced on until we reached a large grove of acacias under whose friendly shade we finally stopped.

Some of us had been without sleep for thirteen days, but it was better, we thought, that we should reach the Delta first, rather than lie and sleep where we were, for although we had almost passed out of the danger area, during breakfast an hostile aircraft had passed high overhead. The smoke from acacia-wood fires made us feel drowsy, and to many of us who had not seen a wild tree growing for over a year, the scene before us was rapidly becoming more and more sylvan as tea followed bacon and tobacco followed tea, and a feeling came over us that of all places on earth this was the spot where we might peacefully spend the remainder of our days. So we pushed on through country marked on the 1 : 500,000 map as "numerous groves of trees in shallow depressions." It was still flat gravel country rising a little towards the east in gentle undulations with groves of acacia trees growing in the hollows. To the north could be seen the blue outline of the Depression escarpment.

It had been arranged that a relief party with petrol should meet us on the main track to Cairo, but after lunch we lost the track for this part of the desert seemed to be a mass of tracks running in every direction. However we continued on a Cairo bearing until we suddenly stumbled across them. Besides petrol, they had brought out dates, sweets, and tobacco, and as we were excitedly exchanging news, we were disturbed by aircraft for the last time. We drove eastwards at speed out of the acacia country across the rolling desert plains, past clumps of tamarisk bushes, until the evening came. We drew our vehicles up in a circle, turned on the dance music from Cairo,

helped ourselves to rum and limes, and prepared for our first night's solid sleep. Since we had left the Western Escarpment of the Depression the night before, we had done an 80-mile night drive, and during the day we had travelled another 100 miles.

When I awoke the next morning I found my head resting against the rear wheel of my jeep, my bedding roll untouched in the back, and my mess tin full of last night's bully stew. Later in the day we crossed the Bahariya track, and after many more miles, as the sun began to cast long black shadows, we topped the last ridge. Below us lay a wide luxurious belt of palms; through the palm trees and paddy fields ran the Nile. We picked up our glasses and recognized the familiar minarets of the citadel just visible against the blue cliffs. Wearily we dismounted our guns and turned towards the pyramids. We parked the jeeps outside the Mena Camp Naafi, and three bearded officers slunk into the Mena House Hotel and ate, not out of dusty mess-tins, but off clean white plates.

THE OBSERVATIONS OF AMUNDSEN AND SCOTT AT THE SOUTH POLE

ARTHUR R. HINKS, C.B.E., F.R.S.

SOME seven years ago, in reviewing a book on the life of Peary, I had occasion to calculate by the position line method his four observations at the Pole, that had been calculated elaborately, but, as it seemed to me unsuitably, by methods of spherical trigonometry more proper to lower latitudes (*Geogr. J.* 89 (March 1937) 255 and 90 (August 1937) 167). I was interested to see how simply and conclusively these position lines illustrated and confirmed Peary's narrative of what he did to fix his position at the North Pole, and I resolved to apply one day the same method to the observations of Amundsen and of Scott's navigator, Bowers, at the South Pole. Other matters intervened, and it was only last winter that I found opportunity to collect the material, and time in long evenings on duty to study the observations made by the Norwegians and the British in December 1911 and January 1912.

The Norwegian and English editions of Amundsen's book, published in the autumn of 1912, contain certain figures in the narrative, a few pages of facsimiles from his observation books as illustrations, and a brief appendix dealing in a curiously incomplete and unsatisfactory way with his final observations at the Pole. But so far as I can discover, the bulk of his results have never been printed, and if the original observation books survive, they are unfortunately now inaccessible. One map in the narrative shows the Norwegians marching poleward along meridian 169° W., and another map shows them as on the meridian of Framheim about 163½° W. So the route of the expedition is not too well documented.

The surveys of the British expedition produced fourteen maps, which were

published in 1923 in a volume 'British (*Terra Nova*) Antarctic Expedition 1910–13: Report on Maps and Surveys.' The Preface says that Colonel H. G. Lyons, F.R.S., as Honorary Editor of the Physical Reports of the Expedition, had originally planned a Memoir which was to contain a critical discussion of the more precise work, to be written by himself, as well as full reports of the various officers concerned with the survey work. Lieutenants H. L. Pennell, R.N., and H. de P. Rennick, R.N., Commander and First Officer of the *Terra Nova*, had reduced all the primary positions and drawn some of the maps, but both lost their lives in the war of 1914–18. Colonel Lyons was never able to write the proposed Memoir, and he entrusted the whole publication to other hands.

The Meteorological results of the *Terra Nova* expedition are published in three large volumes, one of discussion, one of charts, and the third tables of observations. We shall refer to these as Meteorology.

Scott's march to the South Pole

The only account of the astronomical positions determined on Scott's march to the South Pole is contained in Chapter V of eight pages in the 'Report' above mentioned. It begins when the last supporting party turned back on 4 January 1912 in 87° 32′ S. 160° 41′ E., not W. as is printed on page 25. From this point Bowers took over the principal part of the observations, making on most days circum-meridian sights for latitude during the lunch-time halt, and sights for longitude at the evening camp: all in the best tradition of the conservative naval officer. Scott had been present at a meeting of the R.G.S. in 1909 when the simple method of graphical determination by position lines when near the Pole had been described (*Geogr. J.* 35 (March 1910) 299), and he had taken part in the discussion, but was unconverted. So Bowers persisted with his circum-meridian latitudes near noon until January 15, though he had in fact been making a mistake in his reduction to the meridian, which was of small effect only because he was so near to the Pole. On June 15 he gave up this reduction, and his evening sight on that day was the last which he worked up as a longitude. On January 17 and 18 all his sights were worked as if they were meridian altitudes, and the Report has treated them as if they were, with the strange remark "there being, of course, no such thing as a circum-meridian sight at the Pole."

At this point it becomes evident that there is something seriously wrong, not with Bowers, but with the Report's exposition of what he did; and as the Report gives none of the original figures, except one facsimile page from the observation book of the last observation near the Pole about noon on January 18, it was necessary to seek the original observation book, preserved at the Scott Polar Research Institute at Cambridge. With great kindness the Director of the S.P.R.I. first copied all the figures for the last five observations and their reduction, and later deposited the original at the R.G.S. for my use. Each observation had been worked on the original page of the observation book, a thin sketch-book of blank detachable pages, with nothing to keep the record in a standard form, so that the figures of the calculation are all over the place, and require some identification. But they are beautifully written, and there is no serious difficulty in disentangling them.

The book begins with the departure position on the return of the Supporting Party under Lieut. Evans on 4 January 1912:

Lat. 87° 32′·3 S. Long. 160° 41′ E. Var. 180°
Watches at 8 p.m. 3rd
S. $0^h\ 2^m\ 11^s·4$ fast on G.M.T. losing ·76 secs daily
T. 2 7 59·1 fast on G.M.T. losing 4·23 secs daily

Watch S soon became irregular, and T was used in all the observations.

The combined parties had reached the head of the Beardmore Glacier and emerged onto the polar plateau in longitude 160°; they kept as close to this meridian as possible all the way to the Pole, determining the variation of the compass by observations which are a little difficult to interpret, and checking their meridian by longitude observations and calculations which necessarily became less effective as the latitude became extreme. Instead of re-examining these calculations in detail I propose to plot them all afresh as giving position lines.

The method is the simplest possible; with our approximate knowledge of the Greenwich Apparent Time of the observation we can lay off the bearing of the Sun. Having corrected the observed altitude of the Sun for refraction and parallax, one compares the corrected altitude with the Sun's declination interpolated from the Nautical Almanac. If the altitude is greater than the declination, the observer is somewhere on a line which is at right angles to the direction of the Sun, and displaced from the Pole towards the Sun by the amount of the difference Altitude minus Declination. If the declination is numerically greater than the altitude, the line is displaced away from the Sun by the amount of the difference. It matters not whether one is observing near local noon or at the evening camp or anywhere in between; the method is exactly the same, of the most direct and engaging simplicity, and the resulting position line gives the whole of the information that the observation provides.

The lines in Fig. 1 more or less at right angles to the meridian 160° East of Greenwich are derived from the observations made during the halts for lunch; those lying more or less along the meridian are from the observations at the evening camps; observation number 3 was made at a temporary halt on a morning march. To get the complete position of the evening camp one moves the lunch-time line towards the pole by the distance shown by the sledge meter during the afternoon march. The intersection of the lunch-time line thus shifted by dead-reckoning to the evening camp is shown in figure 1. The navigation was first-rate; no camp is as much as a mile right or left of the meridian along which they were trying to march, and the graphical solution (Fig. 5, p. 174; the scale of Fig. 1 is too small) shows camp 68 a little left of the meridian, as Bowers' observation worked up by him for longitude made it; not several miles to the right, as the diagram on page 29 of the Report plots it (Fig. 6, p. 175). The 'miles' throughout this discussion are geographical miles or minutes of arc.

This figure 1 brings us to the evening of January 16, the day of the great disappointment. On page 543 of 'Scott's Last Expedition' his journal reads:

> We marched well in the morning and covered 7½ miles. Noon sight showed us in Lat. 89° 42′ S., and we started off in high spirits in the after-

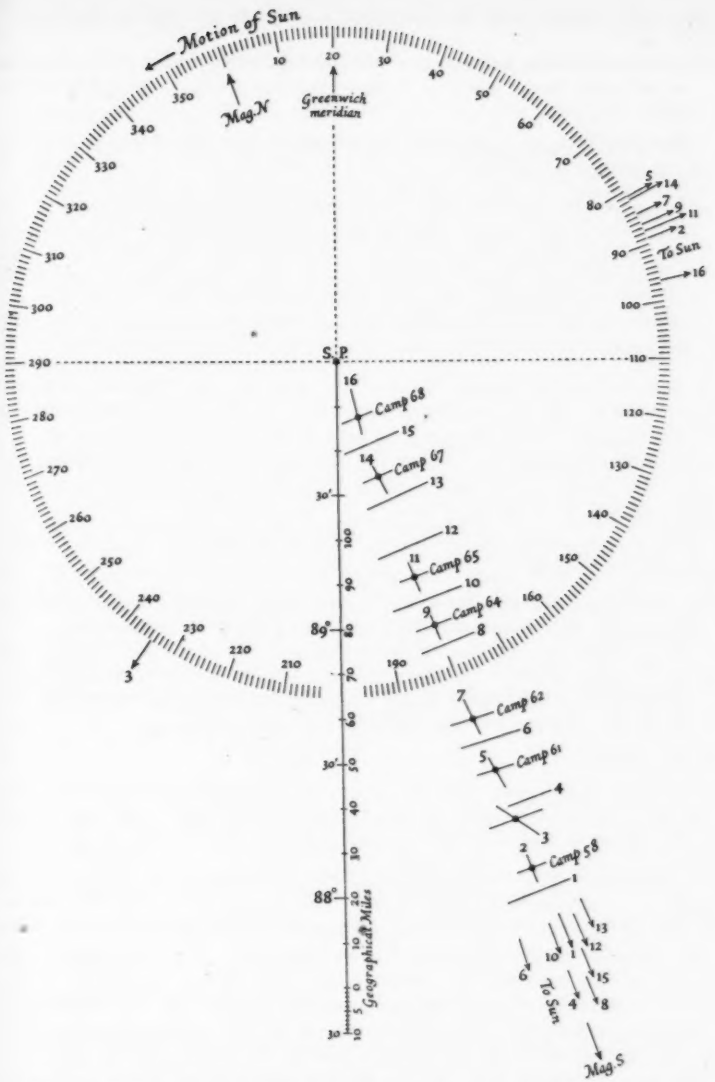


Fig. 1. Position lines from Bowers' observations, Camp 58 to Camp 68

noon, feeling that tomorrow would see us at our destination. About the second hour of the march Bowers' sharp eyes detected what he thought was a cairn; he was uneasy about it, but argued it must be a sastrugus. Half an hour later he detected a black speck ahead. Soon we knew that this could not be a natural snow feature. We marched on, found that it was a black flag tied to a sledge bearer; near by the remains of a camp; sledge tracks and ski tracks

going and coming and the clear trace of dogs' paws—many dogs. This told us the whole story. The Norwegians have forestalled us and are first at the Pole.

Wilson's account, quoted from his journal by Seaver in 'Edward Wilson of the Antarctic,' p. 278, is:

Jan. 16. We got away at 8 a.m. and made 7·5 miles by 1.15, lunched, and then in 5·3 miles came on a black flag and the Norwegians' sledge, ski, and dog tracks running about N.E. and S.W. both ways. The flag was of black bunting tied with string to a fore and after which had evidently been taken off a finished-up sledge. The age of the tracks was hard to guess, but probably a couple of weeks—or three or more—the flag was fairly well frayed at the edges. We camped here and examined the tracks and discussed things.

It is fortunate that Wilson records "we camped here" and that Scott has "nearby the remains of a camp," which was evidently the Norwegian camp of the evening of December 13: its latitude by account, 89° 45′, agrees well with Bowers' 89° 45′·6 for Camp 68. We shall see that the coincidence of these two camps is an essential factor in the solution of the problem: What did each do on the following day?

Up to that point Scott had been heading straight for the Pole; but on January 17 he writes:

"We started at 7.30, none of us having slept much after the shock of our discovery. We followed the Norwegian sledge tracks for some way; as far as we can make out there are only two men. In about three miles we passed two small cairns. Then the weather overcast, and the tracks being increasingly drifted up and obviously going too far to the west, we decided to make straight for the Pole according to our calculations."

Wilson says:

"In the morning we were up at 5 a.m. and got away on Amundsen's tracks, going S.S.W. for 3 hours, passing two small snow cairns, and then, finding his tracks too snowed up to follow, we made our own bee-line for the Pole."

Amundsen's track cut Scott's obliquely. The diagram in Report (Fig. 6) makes it nearly parallel to the meridian of Framheim 163° 37′ W.; but in getting up from the barrier to the plateau the Norwegians had borne to the right, and the head of the ascent is in about 169°. If on the plateau they steered on this meridian they would have been marching on about N. 32° E. Magn. at the point where they intersected the meridian 160° E. The diagram illustrating the Appendix IV of Amundsen's second volume (English) makes the bearing about N. 51° E. but this will be found inconsistent with other observations; it must have been in the neighbourhood of N. 30° E. if in the neighbourhood of the Pole the Magnetic Meridian is as shown in our plotting. Why Scott, who had been marching so straight to the Pole, was hypnotized into following Amundsen's trail when it cut across his own is hard to understand; but he did so for some three hours, and put himself several miles off his course. When they realized that this was a mistake they reverted, I think, to their former compass course, Magnetic North, and after a halt for lunch they marched $6\frac{1}{2}$ miles more on what Scott calls due south

and then made Camp 69. Here Bowers made several observations at intervals during the night.

All these, with the lunch observation that day, and that at the Pole lunch-camp the next, were worked up by Bowers as if they were meridian sights for latitude, and have been treated as such in the Report, which goes so far as to deduce a probable error for Bowers' latitudes from the divergences from the mean of the various sights at Camp 69. But it is clear that Scott and Bowers on the morning of January 18 realized that these were not all latitudes: had they been, they would have given no indication on which side of the Pole they were. Scott's journal says: "Decided after summing up all observations that we were 3·5 miles away from the Pole—one mile beyond it and 3 to the right. More or less in this direction Bowers saw a cairn or tent." One may easily reconstruct their summing up.

The observations at the Pole

The observed altitude, corrected for level, refraction, and parallax, is the corrected altitude, and 90° minus this is the corrected zenith distance. In the southern hemisphere, when the Sun is on the meridian at local noon the sum of the zenith distance and the southern declination of the Sun is the Latitude south. When the Sun is on the meridian at local midnight the sum of the zenith distance and the declination comes out greater than 90°, and the latitude is 180° minus this sum. At intermediate hours the sum of the zenith distance and the declination is nearer to 90°, and passes through 90° when the Sun is about six hours from the meridian.

Bowers worked up the six observations at the Pole, five at Camp 69 and one at the lunch camp on the following morning, in this way, and the following figures are extracted from his observation book:

Obs.		18	19	20
G.M.T.	.. Jan. 16	19 18 27	19 30 11	21 4 44
Corr. alt.	..	21° 2′25″	21° 2′51″	21° 1′36″
Zen. dist.	..	68 57 35	68 57 9	68 58 24
S. Decl.	..	20 59 28	20 59 23	20 58 37
Sum ..	..	89 57 3S	89 56 32	89 57 1S
	Mean 18, 19	89 56 48S		

Obs.		21	22	23
G.M.T.	.. Jan. 17	4 29 3	7 3 31	13 14 3
Corr. alt.	..	20°55′31″	20°50′48″	20°51′43″
Zen. dist.	..	69 4 29	69 9 12	69 8 17
S. Decl.	..	20 54 25	20 53 54	20 50 57
Sum ..	..	89 58 54	90 3 6	89 59 15S

The four sights in No. 18 are all on face right, and in No. 19 all on face left. Bowers has correctly taken the mean of 18 and 19 and treated this mean as one observation. The Report treats them as two, considering this "of course quite sound in the unique position of the observer in this case," as if being 3 miles from the Pole somehow eliminated the collimation error of the theodolite and the index error of the level.

The Report rightly observes, on p. 26, that in calculating 21 Bowers had

made some mistakes (which had been corrected in Scott's writing) but that the correction to the watch had been omitted (so that the declination was wrong). But Report does not remark that owing to an error in multiplication the declination was wrong anyhow. Scott made the sum 89° 58′ 54″ as above; Report "on re-working with all corrections" makes it 89° 59′ 12″; my calculation is 90° 0′ 34″ with Bowers' refraction tables, or 90° 0′ 50″ with those in 'Hints,' vol. I. (See below, p. 167: *Recalculation*).

Scott calculated No. 22 himself, and when he arrived at the sum 90° 3′ 6″ he subtracted it from 180° and wrote underneath it 89° 56′ 54″ without remark. But he must very soon have seen the significance of this sum greater than 90°; it was no doubt the key which led to the correct summing up.

The Report remarks on No. 23 that "The observed figures are in Captain Scott's handwriting; in fact he has initialled a correction, so that Bowers was probably observing, though he usually booked his own observations." Now it is easy to distinguish between the numerals of Scott and Bowers; the former wrote 9 with a straight tail, and the latter wrote it with a strong curl. A glance at the observation book shows that Scott recorded all the observations 18 to 23; that Bowers worked up 18 to 21; that Scott corrected Bowers' calculation of 21 and calculated 22 himself. They both worked up 23.

No. 23 was reduced first by Scott and then by Bowers; they agreed within a second of arc, but accidentally. The Report points out that Scott "applies the wrong sign to the bubble correction, uses the refraction correction from a computation made in the morning of that day and does not apply the correction for parallax." The first and third objections are just, but the second was no mistake; the refractions for the five preceding observations had been the same within a second or so. It was Bowers' refraction that might have been criticized; he either made an error or used a different refraction table, which made a difference of 14″. As it is, I think, a more accurate value I have given Bowers result in the above table.

Now when Scott and Bowers "summed up" their observations at Camp 69 they must have seen that at about 7.30 p.m. of the time they were keeping the sum of zen.dist. and S.decl. was about 89° 57′; about twelve hours later, at 7 a.m., it was about 90° 3′; and at 2 a.m. it had been, according to their calculation, about 89° 59′. They rightly concluded that the observation at 7.30 p.m. must have been within an hour or two of local noon, and at 7 a.m. within the same range of local midnight. They were therefore about 3 miles from the Pole, and to the right of it as seen from the way they had come. How they concluded they were a mile beyond it is not so clear; the wrong result for the 2 a.m. sight would have seemed more appropriate to 11 p.m.

However they did it, 'twas a good estimate. The greater is the pity that the Report, failing to understand what Scott and Bowers certainly did comprehend, if perhaps a little vaguely in their fatigue after a night broken with observations, has treated all the observations of this group as meridian altitudes, in spite of the fact that they were made at about 7.30 and 10 p.m., 2 and 7 a.m., and has calculated from their divergences a probable error for Bowers' observations which is about three times as great as it really was. What the Report calls "the bad observation taken at 2 in the morning, which has a residual of 106 seconds" is No. 21, which, as we shall see when we plot the position lines, is bad only because it was as far as possible from being a latitude.

Recalculation of these observations

For plotting the position lines I have recalculated these six observations: we require the Greenwich Apparent Time, the Corrected Altitude, and the Declination of the Sun. The difference between the two latter is the "intercept," and as it is to be plotted in minutes and decimals, or geographical miles, I have calculated these to two places of decimals. The G.A.T. is expressed in degrees and one place of decimals. A tenth of a degree is 24 seconds of time, and the Greenwich mean time carried by watch T may very well have been accurate to within 24^s.

The Report says nothing of the Refraction Tables used by Bowers, except that Sledging Tables, a booklet of 150 pages, were chiefly reprints or adaptations of the tables given in the then current edition of 'Hints to Travellers,' but that the Refraction Tables were differently arranged, which they certainly should have been for these extreme conditions. I cannot find that any copy of these sledging tables has been preserved; even Dr. Mill's collection of polar literature does not contain one. I have myself used the graph provided in the 11th edition of 'Hints' for refraction in extreme conditions, and this makes the refraction correction about 14 or 15 seconds of arc greater than those calculated by Bowers, except in No. 23, where we agree precisely. Bowers had for that one observation multiplied the mean refraction by 0·8 instead of by 0·7. The Meteorological Tables in vol. III, p. 633, make the barometer 0·03 higher than it was at 7.30 a.m.; the temperature was not recorded at the Lunch camp. There are no records of barometer or thermometer in the Observation book, but they are generally given in the Tables just mentioned.

The declinations have been interpolated with second differences, which is just worth while.

Bowers' observations recalculated by A.R.H.

		18	19	20
G.A.T. ..	Jan. 16	287°·2	290°·1	313°·7
Corr. Alt. ..		21° 2′·19	21° 2′·62	21° 1′·38
Decl. ..		20 59.46	20 59.36	20 58.62
Diff.		+ 2.73	+ 3.26	+ 2.76

		21	22	23
G.A.T. ..	Jan. 17	33°·0	103°·4	196°·0
Corr. Alt. ..		20° 55′·30	20° 50′·51	20° 51′·71
Decl. ..		20 56.10	20 53.85	20 50.96
Diff.		− 0.80	− 3.34	+ 0.75

To plot the position line, draw a line from the Pole to the point on the divided circle which marks Greenwich Apparent Time; this is the direction of the Sun at observation. Lay off along this line a distance equal to the difference Altitude minus Latitude, towards the Sun if it is positive, and away from it if negative. A line through this plotted point at right angles to the radial line is the position line on which the observer must be. The intersection of two position lines more or less at right angles gives the observer's place. This is the simple graphical method of finding position within a few degrees of the Pole. It has been objected that a man cannot use geometrical instruments in a sleeping-bag; the precision of Bowers' diagram

of camps and positions about the Pole refutes this opinion. But in any case, if the observation book could have alternate pages with a divided circle and a scale of miles one may sketch the position lines freehand with sufficient accuracy for the immediate purpose, if one can make such good and clear calculations in a sleeping-bag.

The five complete observations made near the Pole are plotted as position lines on Fig. 5, p. 174. They show that the conclusion drawn by Scott and Bowers when they thought over the observations at Camp 69 was near the truth; they were a little more than 3 miles to the right, but not a mile beyond it.

We turn now to the Norwegian observations a month before. These have never, so far as can be ascertained, been published in detail. A plate in the English edition of 'The South Pole' gives a few of the sights made at the camp named Polheim, photographed from the observation book; the Norwegian edition, 'Sydpolen,' gives the full twenty-four. Both editions contain an appendix of a few pages with a very inadequate discussion of them. I am much indebted to Dr. Hugh Robert Mill for lending me his copy of the Norwegian, probably the only copy in England, and to Dr. Olaf Devik for translating the relevant passages. Before the observations are discussed there is a curious confusion of dates to be disentangled.

Amundsen's dates

The *Fram* left Christiansand on 9 August 1910 and Funchal on September 9, passed south of the Cape of Good Hope two months later, was off Kerguelen on November 28, crossed the 180th meridian on 6 January 1911, and moored in the Bay of Whales on January 14, having touched nowhere since leaving Funchal. These dates are from 'The South Pole,' by Roald Amundsen, translated from the Norwegian by A. G. Chater, London, John Murray, 1912. They agree with the dates in the original Norwegian edition, Roald Amundsen, 'Sydpolen,' Gyldendanske Bokhandel, Kobenhavn, 1912. For brevity we will refer to these as English and Norwegian respectively.

A note on page 384 of volume II, Appendix II, Meteorology (English, not in Norwegian) says: The date was not changed on crossing the 180th meridian. This might be read as applying only to the Meteorological Record at Framheim. But the page 33 of an observation book, reproduced on II.85 of Norwegian (not in English), gives a latitude observation at noon on 15 November 1911; the reduction shows, in the value taken for the Sun's declination, that local noon was in advance of Greenwich by about 13^h; that is, they had not changed their date on passing into the western hemisphere, but were keeping Australian date.

The account of the journey to the Pole is covered by chapters X, XI, and XII of vol. II, English, and in a long single chapter "Mot Polen" of vol. II, Norwegian. Both say that the party of five left their base at Framheim on the Bay of Whales on 20 October 1911, but from that point the Norwegian dates are a day later than the English; the twenty-four hours of observation at their polar camp Polheim are from noon to noon of December 17–18, Norwegian, and December 16–17, English. A note at the end of the Norwegian chapter

says that as date was not changed at the passage of the 180th meridian on the voyage of the *Fram* to the Bay of Whales, all dates in this chapter will have to be corrected one day back. Some pedant seems to have persuaded Amundsen to make this very unnecessary change before the *Fram* reached Hobart and despatched to the newspapers the long message which is reprinted in "The First Account" (English I, vii–xix) and in "Den første Beretning" (Norwegian I, 9–26); except that he forgot to change the day of the start for the Pole, which appears in both as October 20 when it should be 19. The change was forgotten also in printing the main text of Norwegian, vol. II, but was made in the English; and it was made in the report on the Astronomical Observations in both Norwegian and English, though neither mentions the change. We may be allowed to call the change pedantic because it makes a discontinuity between the dates of the Norwegian and the simultaneous British expedition: both keeping the Australian date in the field, but the former changing to the American date, except in the principal Norwegian chapter, and in the facsimile reproductions of observation books and reductions which illustrate that chapter. To sum up:

The Australian date, and approximate Framheim Civil Time, about 13 hours in advance of Greenwich Civil Time, or 25 hours in advance of Greenwich Mean Time beginning at Noon, are used in

Norwegian Volume II, pages 1 to 172, Sjette Kapitel, 'Mot Polen,' and on facsimile reproductions of observations in this chapter.

English Volume II, Appendix II, pages 372 to 394, 'Meteorology.'

The American date and approximate Framheim Time about 11 hours slow on Greenwich Civil Time, or one hour fast on Greenwich Mean Time, are used in

Norwegian Volume I, pages 9 to 26: 'Den første Beretning.'
Volume II, pages 408 to 412: 'Overlaerer Alexanders Erklaering om undersøkelsene av observationsmaterialet.'

English Volume I, pages vii to xix: 'The first Account.'
Volume II, Chapters X to XIII, pages 1 to 175.
Volume II, Appendix IV, pages 399 to 403, 'The astronomical observations at the Pole.'

In my discussion I have retained the original Australian date.

The observations at Polheim

The Appendix IV, pp. 399–403 of the English, contains a Note by Professor H. Geelmuuyden, Director of the University Observatory at Christiana (Oslo) which is not found in the Norwegian. He says that having been requested to receive the astronomical observations for the purpose of working them out he had handed them over to a schoolmaster who had so full an insight into the theoretical basis that he was capable of working without being bound down by instructions. This note is a preface; there is no indication that the astronomer ever looked at the results of his action, and his must be the responsibility for the very unsatisfactory treatment that these observations received at the hands of the schoolmaster.

After working up the observations made from 6 a.m. to 7 p.m. the day before at the first polar camp (Sledge camp) which are nowhere published,

Amundsen and his four companions sledged down on the morning of December 17 (Australian date) a distance of 5′₂ geographical miles on compass bearing N.W.1/4W. and set up the small spare tent, which they named Polheim, about an hour before noon; and here they took altitudes of the Sun every hour from noon on the 17th to noon on the 18th. These observations are reproduced in facsimile from pages 168 and 169 of the observation book, on the double-page plate between pages 136 and 137 of the Norwegian, vol. II. Only the second half of this plate is published in the English, and the date December 17 there shown does not belong to this half, which is for the morning of the 18th. The observations were made with No. 1 of the two sextants, and with watch No. 3. The index error is given as minus one minute of arc, but there is no indication of the assumed watch error on Framheim time; the appendix has no trace of barometer or thermometer readings required for calculating the refraction, though these must have been somewhere in the observation books. The published material is therefore insufficient for a complete solution.

I have plotted the observed altitudes corrected for semi-diameter, parallax, and refraction, in the upper line of Fig. 2. It will be seen that the figures

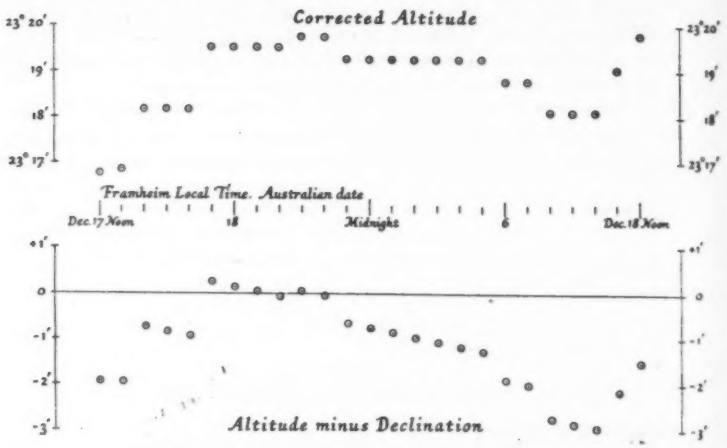
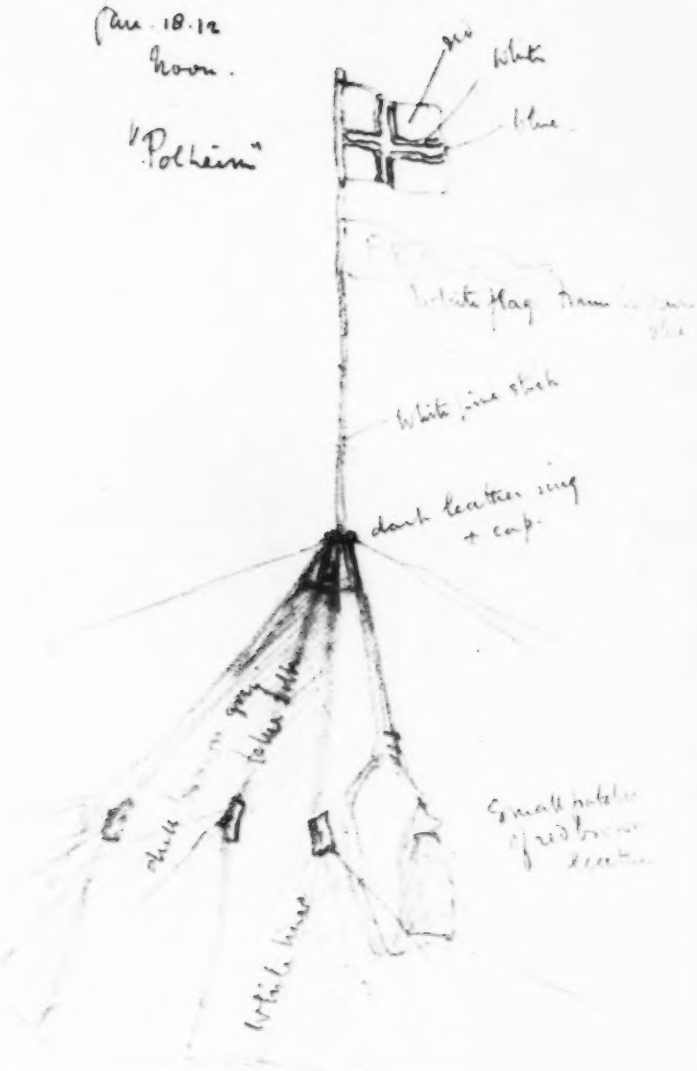


Fig. 2. Norwegian observations at Polheim

tend to repeat themselves for several hours together; thus for seven consecutive hours, from 11 p.m. to 5 a.m. the corrected altitude is 23° 19′.27, immediately following two of 19′.77, which are my highest. The calculator deduces an upper culmination altitude of 23° 19′.2, and a lower of 23° 17′.4, which are "one or two minutes of arc too low," perhaps because he has not applied the index correction. But neither had I, preferring to deduce it, as will be seen. From these two figures he derives a latitude 89° 58′.6, which is "confirmed by the considerable displacement of the periods of culmination . . . caused by the change in the Sun's declination." He concludes from this that Polheim must lie south of 89° 57′ but north of 89° 59′, and on a



This and the following drawings by Dr. Edward A. Wilson reproduced by permission from 'Scott's Last Expedition,' Vol. I

Amundsen's tent 'Polheim' at the South Pole

Norwegian Flag 1, close to Scott's Camp 68

Norwegian Flag 2, where Dr. E. A. Wilson found Amundsen's note discussed in the text

diagram he actually shows the limits of uncertainty in latitude as above and between 30° and 75° E. in longitude: area EFGH in Fig. 3.

A glance at the plotted observations, upper line, shows how vain it must be to look for displacements of the time of culmination due to the motion of the Sun in declination, at this epoch, only a few days from the solstice, and only a mile or two from the Pole. If instead one plots in the lower line the differences between the corrected altitudes and the declination of the Sun, which latter would be the altitude of the Sun at the Pole, it is easy to see that the range of difference is about three minutes, so that the latitude is about 89° 58½′; that the maximum is somewhere between 5 and 10 p.m. and the minimum between 8 and 10 a.m., so that Polheim was displaced from the Pole in the direction of the Sun within an hour or two of 9 p.m. But if the observations are worked up as position lines they give a much more definite result and do more justice to the skill and determination of the observers. Amundsen and his men took the trouble to observe the Sun every hour for twenty-four hours, and every observation of such a series, if properly reduced, can contribute equally to the result: not only those which are near a maximum or minimum.

The observation books give the time of each observation as a round hour: Noon, 1 p.m., 2 p.m., etc., and in default of any knowledge of the watch error we must assume that watch No. 3 was keeping Civil Time of the Framheim meridian, which is 163° 37′ West or 196° 23′, that is, $13^h\ 5^m.6$ East of Greenwich. Thus Framheim Civil Time of the Australian date was $25^h\ 6^m$ in advance of Greenwich Mean Time of the same date, reckoned from noon as in the Nautical Almanac of that epoch. The observation books give also the compass bearing of the Sun at the observation, to quarters of a point (one quarter-point is 2°.8). The differences between the compass bearings at successive observations show that they were only roughly at the intended hours. It has seemed best to calculate the declination, refraction, etc., for the stipulated hours, but to plot the position lines from the compass bearings, assuming that Magnetic North at the South Pole is along the meridian 20° West of Greenwich. There are no published figures of Amundsen's, and it will be well anyhow to use the same figure as we have used for Scott's magnetic bearings.

We have no sufficient data for calculating accurately the refraction correction. On December 11 the temperature, probably at the noon observation, was minus 13° F. On the afternoon they left the Pole it was minus 2°.2, and there are no records in between, nor any barometer heights. Assuming thermometer minus 5° F. and barometer 19½ inches, and using the graph for correction in extreme conditions given in 'Hints to Travellers,' I.256, 7, we have for apparent altitude 23° 20′ a refraction correction—1′.64, and this can hardly be more than a few hundredths of a minute of arc wrong at the worst. It has been applied to all the observations.

The quantities Corrected Altitude minus Sun's Declination are plotted in the lower line of Fig. 2 against the intended time in hours from Framheim noon. In Fig. 3 these numbers from noon are set out on the corresponding compass bearings of the Sun. The position line, with its current number, is set off at right angles to the Sun's bearing, towards the Sun if the altitude is

greater than the declination, away from it if less, and at a distance from the Pole corresponding to altitude minus declination. If the observations were all exact, and there was no index error, these position lines would all intersect at the position of Polheim; but the lines are displaced away from the Sun by a negative index error of about a minute of arc, so that they leave a blank space round about the place of observation, and one can estimate within a few tenths of a minute where Polheim must be. To get a closer determination

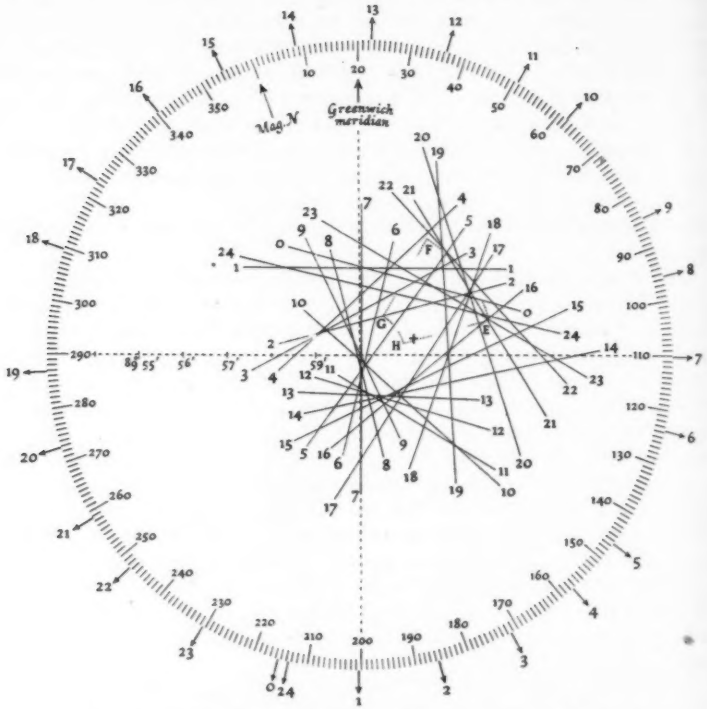


Fig. 3. Position lines from Norwegian observations at Polheim

I think that the best method is to take the observations in fours: 0.6.12.18; 1,7,13,19; and so on, treating the sun by the quadrantal method used for stars.

On each quadrilateral of Fig. 4 describe a circle which will as nearly as possible touch the four position lines. The centre of the circle is the position derived from the four lines, and the radius of the circle is a measure of the sextant's index error. The mean of the seven radii is 1·2 minutes of arc, which confirms the Norwegian figure of one minute. If the seven centres are transferred to a single plotting, it is evident that the latitude of Polheim is about a minute and a quarter less than 90°, and its longitude about 72° East

of Greenwich. If the coordinates of the seven centres are scaled off and the means taken, one finds the latitude 89° 58′·75 and the longitude 71°·6. The graphical method is good enough, and it is evident from the concentration of the quadrilateral centres that the derived position of Polheim must be right within ten seconds of arc or say 320 metres.

The twenty-four-hour programme of observations, performed by Amundsen, Hanssen, Wisting, and Hassel at Polheim, gave then a very much better result than was made to appear in the brief and inadequate report made by the calculator to whom Professor Geelmuyden turned over the task which he had been asked to perform himself. It is a pleasure to demonstrate, more than thirty years after the event, by this simple and obvious graphical discussion, how good those observations were.

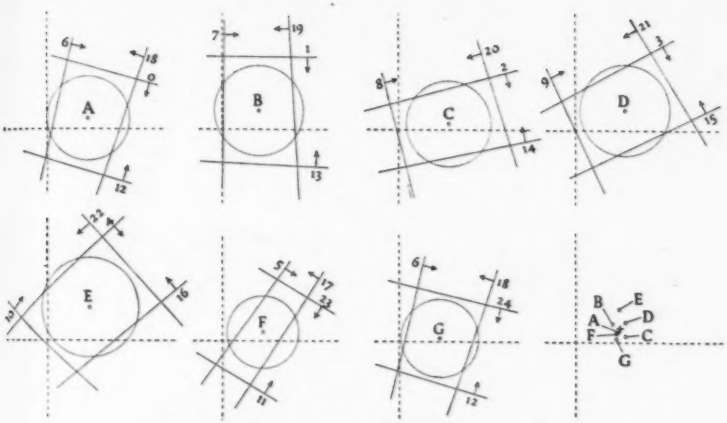


Fig. 4. Polheim position lines in groups of four

The Norwegians and British at the Pole

To make a combined plot of the two parties' movements at the Pole we have as a basis for Fig. 5 three astronomical positions:

The British Camp 68 of the night of January 16, from our plot of the British approach; this is also the Norwegian camp of December 14.

The British Camp 69, determined by four position lines during the night of January 17–18.

The Norwegian camp Polheim, determined by 24 position lines at hourly intervals from noon on December 17.

We have also single position lines for the British lunch camps of January 17 and 18, the latter to be called by Scott the Pole Camp.

The Norwegians set up a sledge at their camp of December 15–17 and left it there as a mark. They had made twelve observations there which have never been published, but they have given the position of Sledge camp as 5½ geographical miles S.E.1/4E. from Polheim.

We must assume that the Norwegians marched straight from Camp 68 to

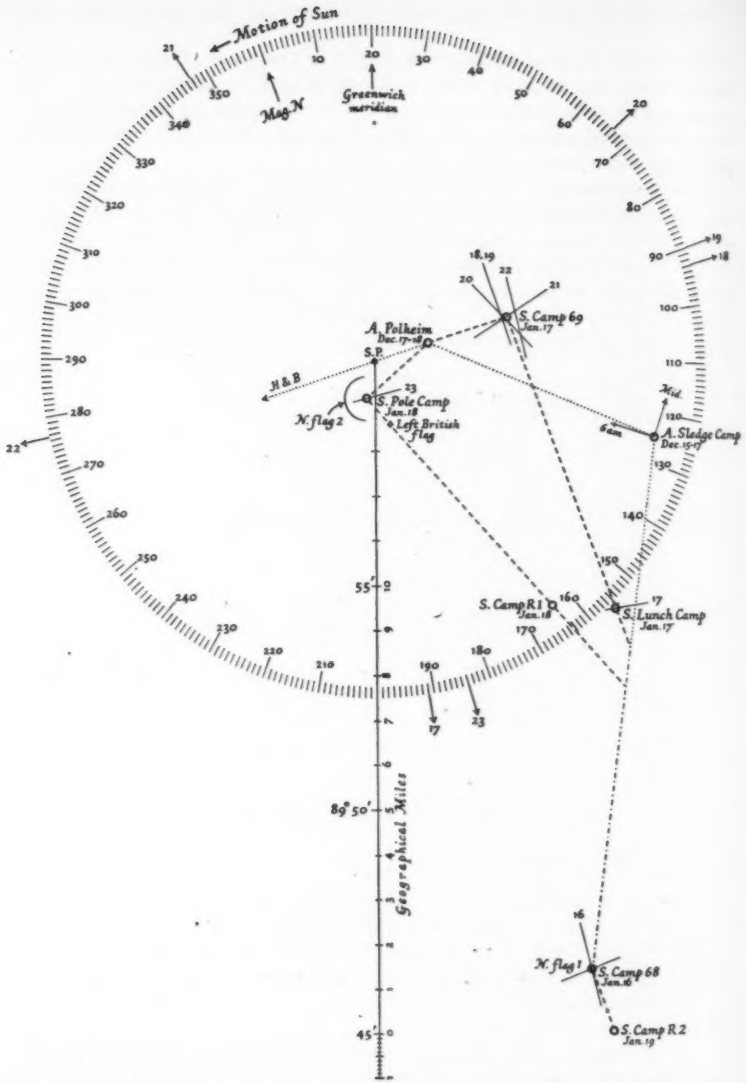


Fig. 5. British and Norwegian positions near the Pole: S British, A Norwegian

Sledge camp. Scott marched along their tracks for several hours, and in about three hours passed two small cairns, but then struck off "on a bee line for the Pole" (Wilson), or "due South" (Scott), meaning presumably the compass course on which they had been marching up the meridian 160° E., that is, magnetic north. Setting off this line back from Camp 69 we find approxi-

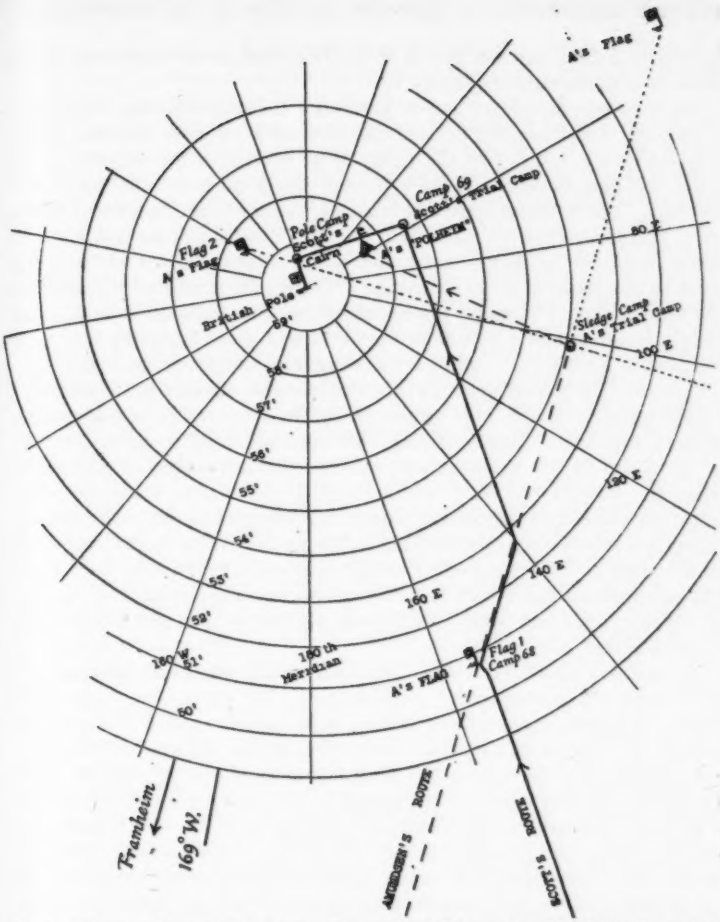


Fig. 6. ***Diagram from the Report, with small additions identifiable by the writing***

mately where the British turned off from the Norwegian tracks, and the intersection of this line with position line 17 gives the position of the lunch camp of January 17.

Scott says that they marched 7·4 miles in the morning and 6·5 after lunch: 13·9 for the day. Wilson gives only incomplete times: over 3 hours and 3½. Bowers' diagram in the observation book makes it 8·1 in the morning and 6·4 in the afternoon: total 14·5. My plot of camps 68 and 69 from a re-reduction of the observations makes the direct distance between the two 14·6 miles, and the two legs of the traverse 8·1 and 7·9, giving 16·0. The astronomical observations seem to make it impossible that Scott's figures for the length of the march can be right, and Bowers' plot does not fit much better, probably because Camp 68 shown on the lower edge of the page should be

beyond it. I think that our plot is as nearly correct as the rather vague data allow, for the marches of January 17.

We have seen how Scott and Bowers, after the early morning observation of January 18 at Camp 69, decided that they were 3·5 miles from the Pole—1 mile beyond it and 3 to the right. More or less in this direction, says Scott, meaning towards the Pole, Bowers saw a cairn or tent, which was Polheim. "We have just arrived at this tent," writes Scott, "2 miles from our camp, therefore about $1\frac{1}{2}$ miles from the Pole," which implies that it was so nearly in the line of march that a diversion to visit it did not add anything much to the distance. Wilson's account: "During the forenoon we passed the Norwegians' last S.^{ly} camp" implies the same, and Polheim is by our plot slightly less than half a mile from the direct line, from Camp 69, not to the Pole, but to Scott's Pole Camp; it was exactly on the line to the Pole.

Page 26 of the Report says that the most probable distance and bearing was worked out to be a little over 3 miles S. 80° W. by compass, with the extraordinary comment "Variation being 180° naturally." What is the authority for the figure 80° W. is not known; our astronomical position for Camp 69 makes the Pole S. 92° W. magnetic. Neither Scott nor Wilson gives the course on which they marched, $3\frac{1}{2}$ miles according to Scott, $3\frac{3}{4}$ by Wilson. Taking 3·6 as the mean, and striking an arc of this radius from Camp 69 to cut the position line from Bowers' single sight at the Pole Camp, we make it 0·85 geographical miles from the Pole on the meridian about 167° West of Greenwich. They had passed the Pole on their right hand half a mile away, and gone a little too far.

At this Pole Camp Scott writes: "We built a cairn, put up our poor slighted Union Jack and photographed ourselves. . . . We carried the Union Jack about $\frac{3}{4}$ of a mile north with us and left it on a piece of stick as near as we could fix it." Wilson (p. 280) says: "Here we lunched—camp—built a cairn—took photos—flew the Queen-Mother's Union Jack and all our own flags. We call this the Pole—though as a matter of fact we went half a mile further on in a S.E.^{ly} direction, after taking further sights, to the actual final spot, and here we left the Union Jack flying." Bowers says in the observation book: "From this position ran down exact distance to Pole by sledge metre and left British flag." Table 73 of the Meteorology, Vol. III, has the note: "18th. Lunch $\frac{3}{4}$ mile N of Pole left British flag on Pole."

All four accounts are consistent with the idea that when they started from the Pole Camp on the homeward march they imagined they were on the far side of the Pole, and would cross it on the way home. Bowers' diagram in the observation book, and the diagram in the Report, page 29, based upon Bowers, though not very carefully, are drawn to agree with this interpretation. But they are all wrong. The observation 23 at the Pole Camp was made when the Sun was bearing South 4° West, Magnetic, as plotted in Fig. 5. Bowers' Corrected Altitude of the Sun was 20° 51′ 43″; the interpolated Declination was 20° 50′ 57″; and my own calculations agree closely with Bowers'. The difference between the altitude and the declination is 46 seconds, which is Bowers' 1500 yards; but the altitude is greater than the declination, and therefore the position line is displaced from the Pole towards the Sun by 1500 yards. When they sledged another 1500 yards in the same

general direction, they were sledging away from the Pole, not towards it: an unhappy mistake, and not easy to explain when they had interpreted so successfully the observations made at Camp 69.

Their compass course when they started for home on the afternoon of January 18 is not recorded by Scott. Wilson says in a S.E.^{by} direction. "After lunch we made 6·2 miles from the Pole Camp to the North again—and here we are camped for the night." Of the following morning Scott says: "Early in the march we picked up a Norwegian cairn and our outward tracks. We followed these to the ominous black flag." South-easterly would have taken them across to their tracks of the afternoon of January 17. I think the natural interpretation of Scott's narrative is that they intersected their Poleward tracks somewhere between Camp 68 and the place where they turned away from the Norwegian tracks soon after they had passed a Norwegian cairn. They marched 1½ miles beyond Camp 68 and made Camp R.2 on the evening of January 18. As plotted the day's march is 10·3 miles, which is reasonable enough when the morning's march was only 3½ miles and they had much to do at the Pole Camp.

I am disposed to think that there is not much more to be made from the available material. My plot differs a good deal from that of Bowers and more from that of the Report (Fig. 6), but both of these are spoiled by the mistake of putting the Pole Camp on the Greenwich side of the Pole, and making the second position of the Union Jack as at the Pole instead of 1½ miles away. Apart from this one mistake by an overtired man, the observations and deductions made by Bowers were excellent: far better than was allowed in the official account of them.

The Norwegian Black Flags

Certain black flags set up by the Norwegians play a conspicuous yet obscure part in the British narrative.

Flag 1 is the black flag close to Camp 68 which showed the British that they were not first in the field; it has been described on pages 163, 164. There is no word about it in Amundsen's narrative.

Flag 2 is the flag about half a mile from Scott's Pole Camp. He says of it (I.546):

> "Less than ½ a mile south we saw stuck up an old underrunner of a sledge. This we commandeered as a yard for a floorcloth sail. I imagine it was intended to mark the exact spot of the Pole as near as the Norwegians could fix it. (Height 9500.) A note attached talked of the tent as being 2 miles from the Pole. Wilson keeps the note."

Wilson says (page 280):

> "At our lunch South Pole Camp we saw a sledge-runner with a black flag about ½ a mile away blowing from it. Scott sent me on ski to fetch it and I found a note tied to it showing that this was the Norskies actual final Pole position. I was given the flag and the note with Amundsen's signature, and I got a piece of the sledge-runner as well. The small chart of our wanderings shows best how all these things lie."

Bowers' small chart in his observation book shows Flag 2 a little less than half a mile from the cairn at the Pole camp, magnetic bearing about N. 35° W.

The diagram in Report does not agree very well with Bowers, and both are so much wrong in placing the Pole camp on the wrong side of the Pole that this evidence is of no weight.

But it is hard to see why Scott and Wilson believed that this flag marked the Norwegian Pole. Wilson brought home the note attached; it is now at the Polar Research Institute, and I have been permitted to study it. On a small sheet of thin yellowish paper is written with pencil in a fine formal hand: "The Norwegian home Polheim / is situated in 89° 58′ S. Lat. / SE by E (comp) 8 miles / 15 Decbr 1911 / Roald Amundsen." Whatever this may mean in itself, it certainly does not mean that the flag to which it was attached was planted to mark the Norwegians' Pole.

There is one indication that Scott found a message from the Norwegians that has not been recorded. They had marked their camp of December 15–17 with an upturned sledge. Scott passed more than 2 miles away from that camp on the afternoon of January 17, but does not mention it and probably did not see it. Wilson, describing Polheim, says "We found no sledge there, though they said there was one." Where can the Norwegians have said there was a sledge, that Wilson expected to see at Polheim? Was it an unrecorded note at Polheim, misunderstood; or another unmentioned note at Flag 2?

Now for the Norwegian accounts of their flag-planting. Having arrived at Sledge camp in the evening of their Framheim time, and started about 11 p.m. to get a meridian sub-polar altitude of the Sun,

> "at 12.30 a.m. we put our instruments away, well satisfied with our work, and quite convinced that it was the midnight altitude we had observed. The calculations which were carried out immediately afterwards gave us 89° 56′ S. We were all well pleased with this result. The arrangement now was that we should encircle this camp with a radius of about twelve and a half miles. . . . Three men went out in different directions, two at right angles to the course we had been steering, and one in continuation of that course. . . . Three small bags of light windproof stuff were made, and in each of these was placed a paper, giving the position of our camp. In addition, each of them carried a large square flag of the same dark brown material, which could be easily seen at a distance. As flag-poles we elected to use our spare sledge-runners, which were both long—12 feet—and strong."

These men set out at 2.30 a.m., carrying three papers of which one has been recovered and is described above. It speaks of Polheim, which had not then been established; one must suppose that they started by calling the Sledge camp by that name. It stated that this Polheim was 8 miles from the place where the flag was to be planted, which suggests that the original programme of marching $12\frac{1}{2}$ miles in each direction had been modified. And it gave the compass-bearing of Polheim from the place where the flag was to be planted: presumably the reverse of the course on which the bearer of the flag was directed. But they had no compasses they could carry, nor any means of estimating distance except by time. They all three came back some time after 10 a.m., to learn that a second observation at 6 a.m. "instead of giving us a greater altitude than the midnight observation, gave us a smaller one, and it was then clear that we had gone out of the meridian we thought we were following. . . . We measured the Sun's altitude at every hour from

6 a.m. to 7 p.m., and from these observations found, with some degree of certainty, our latitude and the direction of the meridian." But the flags were already planted, and it is evident that the compass-bearings inscribed upon the papers they bore cannot be relied upon.

Unfortunately neither Scott nor Wilson gives the bearing of Flag 2 from their Pole camp. Taking it as on a circle of half a mile radius from the Pole camp, the bearing of Sledge camp from the Flag 2 must lie between 122° and 113° E. of N. The bearing S.E. by E. written on the paper is 124°; the magnetic bearing of the line of Amundsen's march, as plotted in Fig. 5 is N. 27° E., or by chance exactly at right angles to the bearing of Scott's Pole camp from Amundsen's Sledge camp. All these figures show that as nearly as can be expected Flag 2 is on a line from Sledge camp at right angles to the direction of approach, and the distance may be as much as 7·6 miles, not so far from the 8 miles of the paper. I think that we may say, then, that Flag 2 may very well be the flag at right angles leftward of the trail, set out by one of Amundsen's "encircling" party, but it cannot possibly be, as Scott and Wilson thought, what the Norwegians took to be the Pole.

The English edition has a plate preceding page 121, entitled "Chart of the immediate surroundings of the South Pole, copyright 1912 Roald Amundsen," which shows a highly idealized plot of the Norwegian route: straight up to the Sledge camp on the meridian of Framheim, and straight on again to Polheim exactly at the Pole. This is a somewhat reduced version of a similar plate in the Norwegian, the first of a batch of unnumbered plates following page 2 of Vol. II; it is signed Tho. Nilsen 6 Februar 1912, which is not on the English version. Nilsen was First Officer and afterwards Commander of the *Fram*; his chart is a fantasy drawn after the return of the polar party to the ship; it is flatly contradicted by the narrative and by the figure in the astronomical appendix. But it shows one thing of interest: a fourth encircling flag something less than 12 miles in rear of Sledge camp, that is to say, about Scott's Camp 68. The narrative says nothing of leaving a flag at this point, still less of anyone going back there with a flag, or planting one there on the way back. But if setting out the flags right and left and forward had been planned before reaching their Pole it would have been natural to begin by leaving one at 68, which is 12 miles from the Sledge camp. This may be the explanation of Flag 1, which gave the first sign to the British party that the Norwegian had preceded them: I can find no other.

Nilsen's drawing shows a similar set of flags disposed about Polheim at a lesser distance, about 8 kilometres, and the Report accepts them, saying that "as at the last camp, three men went out in different directions and set up marks at . . . four miles." The narrative however says that two men went out in the same direction, towards the Pole as determined by the twenty-four hours observations at Polheim, and the narrative must be preferred to the imagination of the *Fram's* first officer. We may then write off the second set of flags as imaginary, and consider Flag 2 as certainly one of the first set, with Flag 1 as the fourth if there were four and not three.

One can but regret that the published results and discussion of the astronomical positions determined on these two historic expeditions are so meagre

and incomplete. Observations made within a few miles of the Pole are so rare and have such special interest that every figure of the records and reductions should have been published. The whole could have been contained in a dozen pages: not very much compared with the 823 pages of figures in the third volume of the Meteorology and the two volumes of discussion. In contrast with the Meteorology, nothing of the astronomical determinations has been printed except some few of the concluded results; and the brief discussion is quite unworthy of their importance, as I have been compelled to indicate. The agreeable feature of the present paper is its main conclusion, that the observations of both parties were very much better than has ever before been represented, and deserve praise that has been long delayed.

Perhaps no one will ever go to the Pole again on foot, and take a twenty-four-hour round of sights to fix his camp. But men may from time to time go by air, and need a convenient method of finding the Pole and confirming it on landing. The method used in this paper works sufficiently well to about 5 degrees from the Pole, and further if one remembers that the position line is really an arc of a circle with concavity towards the Sun, and allows accordingly. If one is equipped with a set of templates to draw arcs of large radius, the method may be extended to 20 or more degrees, as was done by Wilkins in his flight from Point Barrow to Spitsbergen. And if one works with these on a polar stereographic projection it may be extended yet farther. But its prime simplicity is near the Pole, where other methods break down, and there it will from time to time be practised.

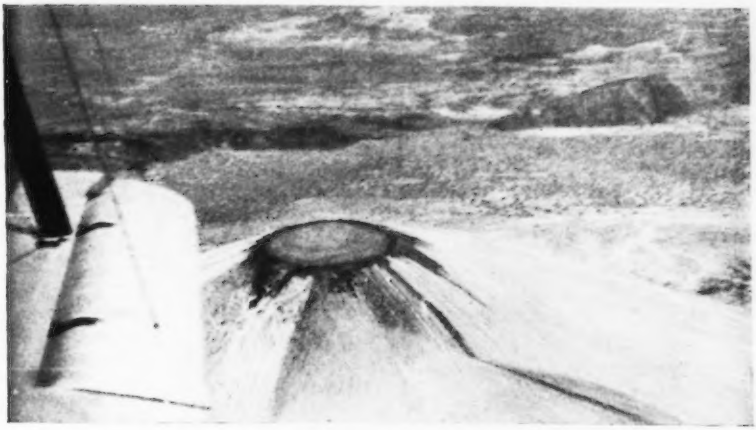
MUD VOLCANOES ON THE MAKRAN COAST

SIR AUREL STEIN'S reference in the *Journal* for November–December 1943 to the mud volcano called Chandragup, near the coast between the Phor river and Sangal, as a place of Hindu pilgrimage, suggested to Squadron-Leader A. J. Young that he should send us some photographs of this volcano taken with a miniature camera on a solo flight in June 1940. Squadron-Leader Young in a second letter describing a flight in September 1940 mentions two hills of dark red colour contrasting with the yellow sandstone of the other hills. He thinks that they were bordering the Basol river and that the western of them would be the hill with spot height 3113 feet in about 25° 45′ N., 64° 10′ E. in the sketch-map illustrating Sir Aurel Stein's paper. The photographs have been submitted to Dr. J. V. Harrison, who has kindly written the following note:

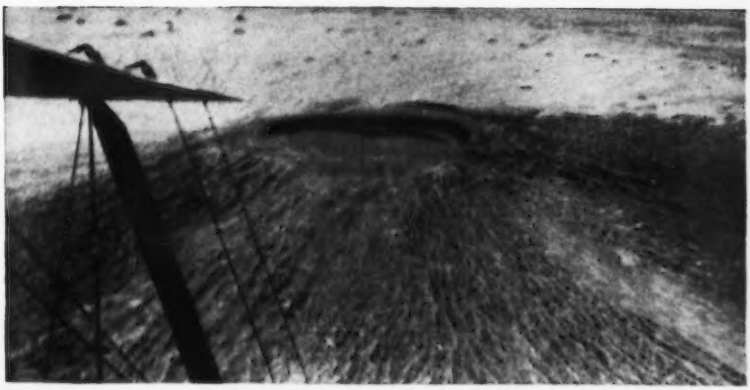
"These mud volcanoes extend all round the Makran coast from Biyaban to British Baluchistan, and three of them were mentioned in my paper on the Coastal Makran (*Geogr. J.* 97 (January 1941) 1–15). One of them discharged a watery mud which would produce a neat cone like Young's. One belched out viscous stuff to form Napag. . . . To the west of Jask there are more of them, and one is very like Young's photo. It occurs near Birz (26°; 57° 29′).

"British Baluchistan was examined by the Burma Oil people long years ago

Chandragup mud volcano from the north



Chandragup from the south



Chandragup from the north

Bulbulak mud volcano from the west

Napag mud volcano

Thok mud volcano

Mud flow from Napag mud volcano

(*ca.* 1914) and so far as I remember Chandragup was their only mud volcano. I think they drilled close by on the strength of it. Many mud volcanoes do show signs of oil, *e.g.* Burma, Trinidad, Venezuela, but this Makran group do not. They discharge cold mud, sometimes with quite a lot of marsh gas. Settling of the very fine silts of that coast and a collecting together of some volume of this marsh gas under the fine silt cover is the only theory I could produce to account for the ebullition. The liquid mud discharge is fairly steady and slight; the viscous mud is sporadic in violent eruptions. Neither volcanic heat nor tectonic folding occur in the parts I know to account for the disturbance, nor from what I remember is the structure near Chandragup tied up with the discharging mud in any clear fashion. Gas separation below and its urge to rise seem to be the motive forces.

"In Persian Baluchistan a red conglomerate is sometimes found in patches amongst the more usual yellow sands and grits. I do not know the occurrence Young describes but in those I do know it appears as if the reddish conglomerate bodies are the result of tumultuous deposits at a river's mouth, for I think that there has been a great wearing down of the whole region. On the other hand we get the 'schuppen' zones inland and there great tiles of unusual coloured rock do project sporadically. Some of these are red, rose, or pink according as they are chert, siliceous limestone, or marl.

"There is no literature in modern geological works on the coast, and beyond Stein's very little geographical. . . . It is country over which Imperial Airways flew at one time and there were some grand views in the *Illustrated London News* perhaps a decade ago."

In the *Journal* for November 1936 (p. 424), there is another mention of a mud volcano in Baluchistan. Mr. C. P. Skrine in his paper about the Quetta Earthquake notes an eruption of a dormant mud volcano on the night of the earthquake, 30–31 May 1935, at Thok, some 12 miles south of Kalat and 30 miles from the southern end of the epicentral zone. Survivors from a nearby shrine told him that "a neighbouring hillock burst with a loud roar, and when day dawned clouds of smoke (probably steam) were rising from it and hot mud oozing in large quantities from a crater at the top." The hill was about 100 feet high, and the mud-flow 300 yards in breadth.

REVIEWS

AFRICA

BRITISH ENTERPRISE IN NIGERIA. By ARTHUR NORTON COOK. *Philadelphia: University of Pennyslvania*, 1943 (*Oxford University Press*). 9×6 *inches;* xii+330 *pages.* 21*s* 6*d*

Nigeria, with its twenty million inhabitants (one-third of the total population of the British Colonial Empire), offers an excellent field for the study of British enterprise, social and economic as well as political, in the tropics. Professor Cook, of Temple University, has written a sympathetic and even eulogistic account of British activities in the country. As an American, the author has the advantage of being able to take a more detached view of events than can the ordinary British student. He has also been helped by meeting a number of the men who made Nigeria, notably Lord Lugard, and by the study of the records of the Royal Niger Company and of documents in the Colonial Office Library and elsewhere. He does not appear to have visited Nigeria. This may account for the brevity of his sketch of the diverse tribes of Nigeria, and for the inadequacy of his account of the physical geography, which here, as elsewhere in the tropics, has played an essential part in the opening-up and development of the country. It may also explain certain obvious mis-statements such as that on p. 240, where the importance of hides and skins in the economy of northern Nigeria is exaggerated, and that of groundnuts unduly minimized.

Most of the book deals with development prior to 1914, and it is disappointing to find only two chapters devoted to modern Nigeria, on which so few studies of the quality of this book are available, especially as recent history so strongly confirms the author's contention that "imperialism is not necessarily vicious and that it is possible for an advanced country to extend its control over weaker peoples to their mutual advantage." Professor Cook is particularly impressed by the administrative and economic policy followed in Nigeria, though he recognizes that the system of indirect rule may need modification in the future. At times he is so carried away with admiration for British enterprise that it hardly seems as if he has been searching enough in his analysis. Yet most people will agree with his conclusion that "the Nigerian experiment . . . has proved of inestimable value in pointing the way toward a better order of things in Africa," and will hope to see experience gained in Nigeria applied elsewhere in the continent after the war.

The author clearly acknowledges his debt to other writers in this field by full documentation, and by the inclusion of an annotated bibliography. What will strike the general reader even more than the geographer is the absence of any map from what is otherwise a splendidly produced volume. R. W. S.

NORTH AMERICA

THE REGIONAL GEOGRAPHY OF ANGLO-AMERICA. By C. LANGDON WHITE and EDWIN J. FOSCUE. *New York: Prentice-Hall*, 1943. 9×6 *inches;* xxii+898 *pages; illustrations and sketch-maps.* [£1 15*s*]

The title of this book is somewhat misleading, as "Anglo-America" here comprises the United States, Canada, Alaska, and Greenland. The latter is included because of "its having become an American protectorate under the Monroe Doctrine." Regional geography, the authors state, "should represent a compromise between similarity of natural landscape, similarity of cultural landscape,

and the functional integration of the two." On this basis, presumably, Anglo-America has been divided into twenty regions approved by twenty-three prominent teachers of geography in American Universities. It is somewhat surprising to discover that two of these regions, the Agricultural Interior and the American Manufacturing Belt, to a great extent cover the same area, and that there is little attempt to integrate the cultural and physical landscapes in these two regions. The method of regional description is similar throughout. The boundaries are first of all stated; the account of the physical setting which follows is so brief as to be almost worthless; next comes a short résumé of the early settlement or of the "sequent occupance" of the region; finally the real body of the description is devoted to economic activities. These last sections so dominate the book as to make it a study not in regional geography, but in regional economic geography.

As an economic geography of North America this book has much to commend it. An enormous amount of up-to-date information, not easily available, has been collected together and generally set out in an interesting way. The brief descriptions of the principal towns in each region are admirable and so are the illustrations, which are excellently chosen. The maps and charts are clear and enable the reader for the most part to dispense with an atlas. The text, on the whole, reads easily; but is saxiculture a better word than quarrying? or was it worth while for William J. Hall to coin the word chemurgy, defined as "the application of chemistry and related sciences to farm-production problems by finding outlets in industry for the crop surpluses"? The final chapter on Anglo-American Unity seems out of place, particularly as the authors have consistently paid more attention to the United States portions of the regions than to their Canadian parts. The reader is not given the information with which to consider the future of United States–Canadian relationships. Instead he has to depend for his judgment on such arbitrary statements as "If democracy in its broadest sense is to survive, it will be primarily through the efforts of Anglo-America, most of all the United States." Furthermore, Englishmen do not call Canada "American," even if Americans call it "British." However the authors finally reach the conclusion that "the interests of all can best be served if Canada remains Canada and the United States remains as she now is, a strong sympathetic neighbour."

This book is presumably intended for University students, for whom the intensive system of sub-headings should not be necessary. The headings detract seriously from the continuity of treatment and have led to considerable repetition. Anything which adds to the weight and unwieldiness of such a cumbersome book should have been avoided. F. R. G.

CENTRAL AND SOUTH AMERICA

EXPLORACIÓN Y CONQUISTA DEL RIO DE LA PLATA, SIGLOS XVI y XVII. By JULIAN M. RUBIO. Vol. 8, series Historia de América. *Barcelona: Salvat*, 1942. $9\frac{1}{2} \times 6\frac{1}{2}$ *inches;* xii+846 *pages; illustrations and maps.* (*In Spanish*)

A great deal of hard work has gone to the making of this account of early times in the regions of the river that we call the Plate. It is the eighth volume in the series on the history of America edited by Dr. Ballesteros y Beretta. Sr. Rubio has gathered his material from many sources and put it together dispassionately; he remarks that the period has been neglected because Argentine history is often regarded "as beginning in 1810." His book covers the first two centuries

following the discovery, and if, at the end of the seventeenth century, the sparse towns of the riverine regions were still young, it was because "explorers, not conquerors, came here, seeking riches, not dominions"; and, as no precious metals were found, settlement by Europeans was a slow process, with no period of great intensity during the first two hundred years.

A succession of expeditionary leaders followed Solis along the river highway, chief path of exploration, each adding new knowledge of the enormous extent of water and plain lying east of the Andes; Mendoza, Ayolas, Alvar Nuñez, Irala, Hernan Arias de Saavedra, and Garay, among them. Some came direct from Spain: others, generally more successful since they were already experienced in American conditions, from older South American colonies. The chief difficulty of the newcomers was the lack of labour; for no native help could be enlisted. The indigenous tribes were fierce warriors and hunters, with no settled towns, no political organization, no great overlords; they possessed no such wealth and industries as the Spaniards had found in Mexico and Peru; they cultivated no land and had no cereals, and therefore no bread. Settlers arriving in the Plata region, whether at Asunción, Santa Fé, or the re-established Buenos Aires, were forced to become farmers. For a long time the great importance of the river was that of a part of the main route to Chile and Peru.

The usefulness of the volume would be enhanced by an index. L. E. J.

AUSTRALASIA AND PACIFIC

HEADHUNTING IN THE SOLOMON ISLANDS. By CAROLINE MYTINGER. *London: Macmillan*, 1943. 8½×5½ *inches;* vi+336 *pages; illustrations.* 15*s*

The title of this book is unfortunate. It is actually the record of the adventures of two young American women who spent several years in the South-West Pacific painting portraits of natives. A genuine artistic interest in new types of their fellow creatures as well as an evident love of adventure was their motive; they started with little financial equipment and paid their way with the help of portrait commissions of Europeans *en route*.

The results of Miss Mytinger's work have been exhibited at the American Museum of Natural History in New York. There are eight photographic plates of some of these portraits and many line drawings, decorative and amusing, to illustrate the book. The plates are excellent. They have the quality of being accurate records of types with no evidence of being posed, as well as satisfying works of art.

It is a pity that no direct clue is given to the date of the expedition, which, as far as one can gather from certain references in the text (the Malaita incident for example), must have been about fifteen years ago. One would like to know whether this record was in fact written at the time and published only recently or if it has been only now written up.

Occasional inaccuracies, such as the use of the term "luluai" for village headman, a Mandated Territories word, in the Solomon Islands Protectorate, may perhaps be explained by the lapse of time since the expedition.

As a record of the experiences of two lone women far from the amenities of American civilized life, coping in the heat with the problems of food and primitive housekeeping, flies, fever, suspicious native models, as well as the idiosyncrasies of white European island society, this account forms a most lively book.

There are flashes of insight into the routine of village life which are interest-

ing. The incidental picture which is built up of European-native relations is on the whole the most interesting part of the book to a sociologist; but it can be recommended to any one with a sense of humour for a most entertaining afternoon's reading. R. F.

THE HOUSE IN THE RAIN FOREST. By CHARIS CROCKETT. *London: Hutchinson*, 1943. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 158 *pages; illustrations and end-paper sketch-maps.* 12*s* 6*d*

Mr. and Mrs. Crockett left the United States in a 50-foot schooner, the *Chiva*, on a combined honeymoon and scientific expedition to New Guinea. With them were: a woman friend, Dillon Ripley an ornithologist, and three other Americans as captain, cook, and seaman. They visited many different groups of islands across the Pacific on their way to Sorong, in the Northern Division of Netherlands New Guinea, where they camped for several months on the flat coast under conditions which many would have found at least discouraging.

Freddy Crockett hunted, Dillon Ripley explored farther afield, while Mrs. Crockett collected anthropological data and wrote this clever and entertaining account of all that befell them. She kept house in a leaf-thatched hut on stilts, and was equally successful in taming all the birds and animals that came within reach and in winning the confidence of Papuan tribes. Her pets are portrayed as sympathetically as the individual natives, they one and all live with you as you read about them and linger afterwards. Stories of cultural traditions are all the more realistic because the chief actors are her friends and acquaintances. She does not mention the language which was used in making these contacts.

It is a pity that there are a few errors. Netherlands New Guinea is spelt without the *s* throughout the book, Japen Island appears as Japan, and one feels a little dubious about "the shrill song of the centipede." But nothing can detract from the racy good humour and the witty personal touches. L. E. C.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

THE WEATHER. By G. H. T. KIMBLE and RAYMOND BUSH. (Pelican Books.) *Harmondsworth: Penguin Books*, 1943. 7×4 *inches;* 188 *pages; illustrations and diagrams.* 9*d*

This volume is to be highly recommended as an introduction to meteorology for the educated public. If a little too condensed for use in schools, university students will find it a helpful prelude to more advanced work. The authors show much skill in explaining common weather processes in a simple and attractive manner, and in throwing light on puzzling facts and paradoxes which are often extraordinarily difficult to track down in more pretentious works. The interests of open-air observers are well looked after. Hill climbers, for instance, should find helpful the simple rule on p. 72 for finding the level at which widespread low stratus cloud is likely to form suddenly and blot out views; the rule however does not apply to local convectional cumulus cloud.

In a volume designed to appeal to walkers and climbers it is regrettable to find the one serious error connected with rainbows (p. 97). In pointing out that the formation of the bow is restricted to times when the sun's altitude is less than 42° the authors say that this explains "why, of course, it is never seen at midday in these latitudes." But the latitude-belt of Great Britain, 50–60° N., is subarctic: the December sun at noon is only about 16° above the horizon in Sussex and 7° in Caithness; the corresponding figures at the equinoxes being 38° and 27°, which means that for only about four or five months round the summer

solstice it is not possible at sea-level to see any segment of a rainbow at midday in the British Isles. No doubt a showery rainbow type of weather is less common in winter than in summer, but it does occur.

The section on p. 180 on volcanic dust in relation to cold winters needs re-writing, as it is inaccurate as to the regional incidence of cold and mild winters. No mention is made of the winter of 1928–29, one of the most rigorous ever known on the mainland of Europe. On p. 111 the rainfall at Seathwaite in the Lake District, 129 inches, is given as an outstanding wet spot, but the rainfall of Stye Head Pass, only some 2 miles away, is up to 180 inches.

The style of the writing is pleasantly colloquial and here and there amusingly cynical, as where, in relation to safety rules in thunderstorms, we are reminded that "swinging a metal-shafted club overhead has been the last mortal act of many a wet-weather golfer." The photographs are clear, striking, and original, particularly the photograph of an Antarctic blizzard advancing like a wall.

L. C. W. B.

METEOROLOGY FOR THE AIRMAN. By JAMES PATON. *Bickley: University of London Press;* 1943. 7×5 *inches;* 124 *pages; illustrations and diagrams.* 3*s* 6*d*

No new ground is broken in this little book, which, as the author confesses, resembles several published during the war with the object of providing an introduction to meteorology for the airman beginning his training. Herein the treatment of physical principles is well balanced and sound. As a textbook to accompany a good course of lectures its value is enhanced by numerous arithmetical examples of altimeter problems, and by questions at the end of each chapter. In common with other books of its class, no practical work or experiments to demonstrate physical principles are suggested; and it appears that the author envisages class-room teaching rather than laboratory demonstration: a sacrifice to secure results by means of a short cut which must impart superficiality to teaching except to pupils well grounded in physics, even by the best instructor. But this is a fault of a system, not of the book. Within the confines of the former, the work may be recommended. Like its congeners, it stops just where aviation meteorology becomes interesting and practical, *i.e.* at the point where the pupil is introduced to daily weather, on the chart and as he sees it, and considers it in relation to flying. Then he should feel grateful for the sound, if rather colourless, instruction to be gained from Mr. Paton's book.

J. H. G. L.

GENERAL

THE BEAUTIES OF SCENERY: a geographical survey. By VAUGHAN CORNISH. *London: Frederick Muller,* 1943. 7½×5 *inches;* 128 *pages; illustrations.* 6*s*

In his Presidential Address to the Society in 1920, Sir Francis Younghusband appealed to geographers to undertake the systematic study of the beauties of scenery: this, he averred, would provide "the knowledge about the Earth which is most worth having, [for] we cannot really know and understand the Earth—which is the aim of geography—until we have seen its beauties, and compared the varying beauties of the different features with one another and seen how they affect man and man affects them." This being so, we ought not, he said, to "tolerate a geographer who will learn everything about the utility of a region for military, political, and commercial purposes, but who will take no trouble to see the beauty it contains. . . . We expect . . . that he should have in him something of the poet and painter."

Almost alone in responding to Younghusband's appeal, Dr. Vaughan Cornish has spent the greater part of the past twenty years adumbrating the principles of "aesthetic geography" and illustrating their application to the practical problem of the preservation of beauty in town and countryside. In this, his latest volume on the subject, Vaughan Cornish offers us what he terms a "geographical manual of scenery." Leaving aside for the moment the question of the relationship between aesthetics and geography, we would merely note the fact that while the preface and the chapter headings encourage the reader to believe the accent will be on geography rather than aesthetics, most of the space is, in actual fact, devoted to topics which he has been brought up to regard as falling within other provinces. The following paragraph headings are representative: the night-sky from the equator, comets and auroras, insects in flight, deep-sea waves, the triumphal arch in scenery, heraldry in the architecture of cities, wood-carving of perforated screens. Even the chapters on the scenery of land and sea, vegetation and wild life, do not follow any discernible geographical pattern, regional or physical: indeed the relation of their subject-matter to geography, as commonly understood, is frequently tenuous, and at times non-existent. Unlike Lord Avebury who (in his 'Beauties of scenery' and 'Scenery of England') was always careful to elicit the connection between scenery and structure, even when "dissecting" beauty, Vaughan Cornish is mostly concerned with the evocative qualities of the things he sees and describes, in much the same way as "the poet and painter." And no doubt, as F. J. Osborn claims in an over-eulogistic Introduction, he does succeed in awakening the perceptive reader's senses to the beauty of the physical world, particularly our own island; but it is difficult to see what use he makes, to quote Osborn again, of his "deep understanding of the wisdom of natural science." Many of his observations are trivial, and some are erroneous, as for instance where he implies that there are coral reefs in the Southern Ocean (p. 42), that longitudinal valleys are necessarily downfolds of the original structure (p. 42), and that clouds over the sea in the Trades collect "as the day goes on" (p. 21), whereas in fact they tend to decrease by day and to increase by night. The following paragraph is characteristic of his style and method: "The ridge-way of Haslemere Heights culminates on the east at Blackdown Hill, sloping steeply to the broad plain (*sic*) of the Sussex Weald, beyond which can be seen the chalk downs and Ashdown Forest. There are no prosaic midway features, and the eye dwells upon the distance which 'lends enchantment to the view' etherealizing the landscape and thus imparting an idea of Heaven. . . . The view as it may happen to appear to one who comes as a visitor to this shrine of scenery [Aldworth House], is merely a single aspect of a varying scene, for the features of the broad prospect are but the outline of a picture ever changing in tone and colour through all the round of hours and seasons in England's variable climate. To live where the outlook is on such a scene endows the ordinary man with poetic feeling, however inarticulate he may be " (p. 102). This is pleasant enough prose, but it contains no more geography than a Turner landscape does meteorology. For geography is not concerned with "poetic feeling," but with plain knowing: in this particular instance, with knowing about the evolution, in time and place, of the harmonious association of those Wealden fields, farms, forests, and villages which greet the eye on Haslemere Heights. This quest calls for academic detachment, unemotional judgment, and good scholarship, rather than the "tactile sensitivity of the child," artistic discrimination, and "the poet's eye in a fine frenzy rolling." With the geographer, the search for beauty must always be ancillary to the search for truth and, unfortunately, in our present world the truth is not always good-looking. By all means let us think upon things that are

lovely and of good report, provided that in doing so we do not remove ourselves so far from reality that the distance lends enchantment even to the ugliness of agricultural exploitation, speculative building, industrial *laissez-faire*, and all the other evils which arise when man gets out of step with his environment.

As if anticipating a rather cool reception for his friend's work, Osborn offers the suggestion that Dr. Cornish is "preoccupied with the search for the components for a novel synthesis," but no synthesis, old or new, is forthcoming. In the 120-odd pages no less than 102 topics are touched upon, and there is so little plan or purpose behind their arrangement, or so little connection between them, that the last chapter might well have been the first. True, many of his descriptions are finely done, but they pose no problems, they preach no gospel, and they raise no vital issues. G. H. T. K.

THE MONTHLY RECORD

SOIL EROSION IN SOUTH AFRICA

Striking photographs of the gullies which are gradually trenching the surface of a great part of South Africa, were recently published in L. C. King's 'South African Scenery.' The author, in the few pages that he was able to devote to the subject, gave a warning of the fate of the veld, which is in danger of becoming "the Great South African Desert." A comprehensive discussion of the problem is now to be found in "Erosion and soil conservation in the Union of South Africa," by J. P. van Aartsen, in the *International Review of Agriculture*, published by the International Institute of Agriculture in Rome (*Monthly Bull. Agric. Sci. and Prac.*, 34 (May 1943) 153–201). Van Aartsen takes a wide view, and discusses the physical features, climate, and natural vegetation, together with the human, social, and economic history of South Africa, showing the intereffects of all these factors on the loss of the soil. His paper is, in fact, a condensed history of many aspects of the Union, some of which have only a very indirect bearing on the problem in hand.

Soil erosion is a widespread curse, and the means of livelihood of certain areas such as Natal are threatened by the progressive reduction of productivity. The chief loss everywhere is of pasture land, and the dwindling of this main agricultural resource is a severe check to the economic development of the Union.

Van Aartsen is emphatic that over all the less arid parts of South Africa, soil erosion is a man-made phenomenon. He drives his point home by stating that in Southern Rhodesia there is very little evidence of loss in the unoccupied areas, whereas it has already set in severely on the cultivated land, especially on the fertile riverside slopes. He demonstrates the various agricultural practices

of both natives and colonists that are having a fatal effect on land naturally susceptible owing to the alternating periods of drought and torrential rain, the undulating or broken topography, the open vegetation, and the hard or shallow soils.

Almost all the Union lies within the dry Trade Wind belt; but since all parts are relatively near the sea, the average annual rainfall over most of the area ranges from 5 to 25 inches. The trouble is not so much absolute lack of rain as its extremely irregular distribution, long periods of drought being followed by torrential downpours. Under such climatic conditions the development of natural vegetation is very slow, and thus if it is destroyed it takes a long while to recover to a condition of ecological stability. The soil is thus liable to be exposed and then scoured out by the rainfall, but severely as gullying often develops, van Aartsen considers that it is less important in South Africa than sheet erosion.

Man's activities have played on the natural susceptibility of the land surface, through cultivation both by natives and by Europeans. The Hottentots and Bushmen, who were in the area when the Dutch first arrived, were in the habit of burning the veld to facilitate new grass growth, and they were soon imitated by the settlers. Owing to their shifting cultivation, the destructive activities of the nomads involved the exhaustion of one area after another, but those of the white farmers, who soon settled in stone-built houses, became localized and therefore intensified.

The worst effects on the soil were felt from the time of the Great Trek onwards, although van Aartsen points out that the Boers under pioneering conditions can scarcely be blamed for initiating what proved to be malpractices, considering the then elementary state of agricultural science in civilized regions. Cattle and sheep proceeded to destroy the natural vegetation by grazing over large new areas; and as by degrees the native agriculture advanced under white influence, so the increase in arable and pasture farming made yet heavier demands on the soil. Among other changes, the natives have learnt to grow commercial crops in rows, thus exposing the soil between them, in place of their former habit of growing all their crops together to form a continuous plant cover.

Van Aartsen however emphasizes overstocking as being a greater source of damage than the growing of crops; this suggests a contrast with conditions in North America where excessive clearing for ploughing is more important. Apart from the destruction by burning in South Africa, the degree of damage caused by which is debateable, the harm done by grazing tends to be both widespread and also locally intensified owing to the necessity for kraaling the sheep at night so as to protect them from jackals. This means that stock-routes are severely trampled and that the neighbourhood of the kraal is bared of vegetation. Directly the soil is exposed it can be carried away either by streams excavating gullies or by intensive sheet erosion, and it is also liable to be blown afar and redeposited as drift-sand.

Van Aartsen discusses the active steps taken by the Government for the prevention and cure of the evil, and he gives particulars of the various experimental and research stations. The fundamental trouble lies in the mere fact of interference with the natural vegetational sequence, but the ill-effects can be checked by strict control of stocking so as to prevent over-grazing; the conservation of forage and silage to relieve grazing pressure in the dry season; rotation of grazing; rotation of crops to ensure humus; and contour ploughing. Extensive contour ridging and terracing of arable land controls the water-flow which otherwise scours the gullies. When they have once developed, the building of

dams within them is the most satisfactory method of checking their growth, and incidentally provides reservoirs of water and thus abolishes the need for trampling routes to the few natural watering-places. The problem of irrigation cannot be separated from that of soil erosion if South Africa's pastoral resources are to increase rather than to decline. M. A. A.

SIR THOMAS DE LA BECHE AND THE GEOLOGICAL SURVEY

In *Endeavour* for January 1944, Dr. F. J. North describes the share of Sir Thomas de la Beche in the foundation of the Geological Survey and the Geological Museum. In compiling this paper he has had access to unpublished material, which make it clear that the initiative came from de la Beche. After retiring from the Army, at the close of the Peninsular War, de la Beche lived at Lyme Regis, where he became interested in the rocks and fossils of the neighbourhood. As his interests developed, he prepared a scheme for a geological map of Devon to be undertaken at his own expense. Owing to the troubled state of Jamaica, whence his income was derived, he had to abandon the idea of independent publication, and applied in March 1832 to the Master General of the Board of Ordnance for assistance. The plan was referred to Colonel Colby, who had already shown an interest in geology. Realizing the importance of making the Ordnance Survey maps into "perfect illustrations of the geological features of the country," Colby recommended the acceptance of the proposal, under which de la Beche was to receive £300 for the work. When the eight sheets of Devon were completed, de la Beche, who had a larger scheme in mind, offered to extend his geological surveys. This offer was favourably received, though the Treasury enquired cautiously as to the time it would require to cover the whole country. De la Beche replied diplomatically that "I consider that the Geological Map will keep pace with the Geographical Map, and consequently that both Maps will be completed at the same time." Finally he estimated that with the help of two assistants the geological map could be completed in about ten years, and the continuation of the work was approved.

Shortly after this, de la Beche proposed that a collection should be formed from the geological specimens collected in the field, and within a month the Museum of Economic Geology, from which the Geological Museum springs, had been established. In 1839, when it was apparent that the work could not be completed in ten years, he applied for permission to engage assistants: the authorities were again anxious to estimate the probable expenditure. This was finally recognized to be impossible, and a solution was found by instructing Colonel Colby to expend from year to year such a sum as might be deemed advisable, in consultation with the Master General and Board. In 1840, the employment of four assistants was approved: since that date the question of the duration of the Geological Survey has not been raised again.

THE EXTINCTION OF THE TEHUELCHE INDIANS

We have received from Captain T. Caillet-Boys a reprint of an article entitled "El fin de una raza de gigantes" contributed by him to the *Boletino* of the Instituto de investigaciones historicas, Buenos Aires. The giants of the title are the Tehuelche Indians of Patagonia. Apart from visitors to the coast, the first traveller to describe these people and their life comprehensively and accurately was George Chaworth Musters, who, in 1869–70, accompanied a party on their annual migration northwards through Patagonia. This paper is largely a summary of the information collected by Musters and recorded in his 'At home with the Patagonians.' His account is particularly valuable as the Tehuelches were even then approaching extinction. The writer warmly praises Musters' enter-

prise and accuracy, and considers him worthy to rank as a traveller with Marco Polo and Livingstone.

The stature of the Tehuelches was much exaggerated by early travellers, Musters estimating their average height at 5 feet 10 inches. The impression of great height was probably produced by their exceptional muscular development and their habit of wearing cloaks reaching to their feet. Musters estimated the number who assembled to elect a new chief at one thousand five hundred persons. These nomads were harried by Araucanos, descending from the western mountains to seize cattle for sale in Chile, and even at this time they existed in part on subsidies from the Argentina Government. They were however an attractive and capable people, and the character sketches of the chiefs given in this paper show them to have been men of considerable ability.

With the gradual advance of settlement the Tehuelches declined in number, despite the sympathetic efforts of F. P. Moreno, whose record supplements that of Musters. They proved unable to adopt a sedentary life; on a visit paid in 1917 to an encampment in Santa Cruz, Captain Caillet-Boys found three hundred natives of mixed Tehuelche blood still trying to follow their traditional ways.

COLONIAL RESEARCH FELLOWSHIPS

The Colonial Office announce that the Secretary of State for the Colonies has decided to institute a number of Colonial Research Fellowships, open to University graduates in the natural or the social sciences, for research work in the Colonial Empire. The Fellowships will be awarded by the Secretary of State on the advice of the Colonial Research Committee. They will normally be reserved for University graduates under thirty-five years of age, with experience of research and giving evidence of high ability. The Fellowships will be tenable for two years or possibly three if the work of the first year is satisfactory. They will carry a basic allowance of £400 per annum, which may be increased to £600 if the Fellow is married; travelling expenses will also be paid. The Fellowships will be tenable in any part of the British Colonial Empire. Fellows may be attached to centres of higher education in the Colonies and required to give occasional lectures. The Fellow will be responsible to a supervisor, through whom he will submit a concise progress report yearly and a full report on completion of tenure.

Applications should be addressed to the Secretary, Colonial Research Committee, Colonial Office, London, S.W.1, with statement of qualifications, as set out in the Colonial Office Paper, Miscellaneous No. 509, of which a few copies are available at the House of the Society.

OBITUARY

HERBERT WARINGTON SMYTH, C.M.G.

Warington Smyth, who died last December, was known, apart from his distinguished public career in South Africa, as a traveller in Siam in the 'nineties and as an authority on sailing vessels.

In 1891 he entered government service in Siam, first in the Department of Mines, of which he became Director-General, and later in the diplomatic service. In the course of his duties he travelled extensively through the country, his journeys including a descent of the Mekong valley, a visit to the Mergui pearl fisheries, and an adventurous voyage along the western coasts of the Gulf of Siam. He described his experiences in papers published in the *Journal* and in several books, illustrated by attractive drawings. In 1901 he went to South Africa, first as Secretary for Mines in the Transvaal, and then, on the establishment of the Union, as Secretary for Mines and Industries, and Chief Inspector of Factories for South Africa, until his retirement in 1927.

He was an enthusiastic and lifelong yachtsman, a taste inherited from his grandfather, Admiral W. H. Smyth, the hydrographical surveyor and a founder of our Society. During the war of 1914–18, he served in the R.N.V.R. in the South-west African campaign and at the Cape, retiring with the rank of Lieut.-Commander. His book 'Mast and sail in Europe and Asia,' a second edition of which appeared in 1929, incorporated the results of his wide experience and research, and much detailed information on the design and development of a great variety of sailing craft. Warington Smyth became a Life Fellow of our Society in 1894, and in 1898 received the Murchison Grant for his work in Siam.

MEETINGS: SESSION 1943–44

Owing to damage to the Hall by enemy action no Meetings of the Society could be held in March or in the first half of April.

The following were elected Fellows of the Society at the Meeting of the Council *On 6 March 1944:* John Manley Bendall; Mrs. Nancy Cotton, B.A.; John Alexander Cowie; Mrs. John Charles Codrington Coxhead; David John Davies; Captain Hugh Kingsley Fairbrother, M.B.E.; Gordon Glynne-Walton, B.C.D.; Mungo E. Hepburn; Miss Peggie M. Hobson, B.SC.; Peter Asken de Vine Hunt; Raymond Jessop, B.A.; Ole Gerhard Kiilerich; A. Geoffrey Powell; Dr. Khurshedjee Jamshedjee Rustomjee, M.R.C.S., L.R.C.P.; Lieut. Clifford Ronald Vivian Tandy, R.A.; Captain Philip Raymond Thomas, R.E.M.E.; Lester Wendell Trueblood, M.A., PH.D.; Mrs. Alec Balfour Williamson.